John
Cranford,
M.D.

A

TREATISE on the BLOOD,

OR, GENERAL ARRANGEMENT OF

MANY

IMPORTANT FACTS,

RELATIVE TO THE

VITAL FLUID.

WITH

SOME CURSORY OBSERVATIONS

ON THE

THEORY OF ANIMAL HEAT.

INTERSPERSED WITH

PATHOLOGICAL and PHYSIOLOGICAL REMARKS

FROM THE

INDUCTIONS of MODERN CHEMISTRY.

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Tandem immortalis Harveus diſpulſis antiquæ medecinæ tenebris ingens lumen attulit anatomicis imprimis ac Phyſiologicis rebus diu per experimenta in vivis a primalibus inſtituta detegeret ac publicis ſcriptis demonſtraret ſanguinis circulationem.

M. Ambros Marherr.

By HUGH MOISES,

SURGEON OF THE WESTERN REGIMENT OF MIDDLESEX MILITIA, AND LATE SENIOR PUPIL TO THE GENERAL HOSPITAL NOTTINGHAM.

W Bq 430

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Crawford

TO

JOHN STORER, M. D.

PHYSICIAN

TO THE

GENERAL HOSPITAL, NOTTINGHAM,

AS A

Mark of Respect

DUE TO THE CHARACTER OF A MAN HONOURED AND ESTEEMED BY ALL WHO HAVE THE HAPPINESS TO KNOW HIM.

AND, AS

A TRIBUTE OF GRATITUDE

FOR PERSONAL FAVOURS CONFERRED IN A MANNER TRULY WORTHY THE PHILOSOPHER.

THE FOLLOWING PAGES ARE INSCRIBED,

BY HIS OBLIGED

AND DEVOTED

HUMBLE SERVANT,

THE AUTHOR.

ALSO TO THE

Rev. HUGH MOISES,

NEWCASTLE UPON TYNE.

P. S. D.

I Should indeed be unworthy of the kind attention you have ever beſtowed on me as your nephew, could I forget the gratitude I owe you; and not avail myſelf of the opportunity now offered of acknowledging the numerous obligations I lay under to you from your ever anxious ſolicitude in regard to my welfare.

It

It muſt ever be pleaſing to a grateful heart, to ſpeak of the good offices of a friend; but more eſpecially when the connection we have with that friend is ſtrengthened by the ties of conſanguinity: how much more exhilirating then muſt be that pleaſure, when not only all theſe circumſtances coaleſce, but even to that friend are owing the advantages that have accrued to me in the cultivation of the moſt enlightened and benignant of ſciences.

To make uſe of compliment I am well perſuaded would be equally unworthy of yourſelf and me.

Suffice it then to obſerve that the only motives I could entertain in this dedication, are to pay, through the medium of this eſſay, the tribute of gratitude due

to

to your benificence, and to aſſure you that an anxious thirſt after the knowledge of facts, and for the advancement of ſcience, could alone induce me to enter on the world in ſo queſtionable a ſhape.

That this laudable intention may in ſome meaſure be fulfilled ; and that this may not altogether prove an *Acharifton* is the moſt ardent wiſh of

YOUR DEVOTED,

HUMBLE SERVANT,

HUGH MOISES.

ERRATA.

Page	Line	Read
5	15	nutritious
7	5	animal
12	22	exanimated
14	18	De Haen
19	1	Cafes
24	note	Calore
42	note	abound
44	note	occurs
49	8	phenomenon
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54	note	obſervationes anatomicæ
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73	1	inſpiſſated
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90	2	phenomenon
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The reader is requeſted to correct ſuch other errors as the author is ſenſible muſt exiſt; from the haſty manner in which the work has been printed.

PREFACE.

MAN has implanted in his mind a keen desire of knowing whatever can be discovered, either respecting himself, or the objects which surround him. But the too great eagerness and impatience with which we almost universally attempt the acquisition of this knowledge, too often leads to hasty and erroneous conclusions.

Time seems as it were to sanction this general diffusion of error, and from custom alone it has become venerable; insomuch that should we have courage enough to attempt its detection, it is probable we may be branded with the epithet of madness or profanity.

"Error,

"Error, ſays a very ingenious and truly enlightened author*, triumphs in the ſmiles and countenance of the great, it is diſtinguiſhed by titles and rank, and enjoys the ſolid ſupport of emolument; and truth, which had all along been the pretended object of purſuit, is firſt thruſt down to the bottom of the pit, and then buried deeper and deeper under the ſucceſſive ſtrata of falſe knowledge. Genius is diſgraced, diſcovery aſſaſſinated, and dulneſs eſtabliſhed in all the pride of eminent ſtation."

Cauſes have been aſſigned before a ſufficient number of facts have been collected, and attempts have been made to reaſon from phenomena not ſufficiently underſtood, to others equally unknown; thus, inſtead of obſerving and ſtudying phenomena laborioufly, and patiently collecting facts, and gradually tracing theſe to more general facts, till at length they arrive at one which

* Vide Brown on Phyſic.

ſerves

ſerves for a common connecting cauſe, the order of nature in philoſophizing is inverted, and the more general practice has been to begin with the aſſumption of a fancied cauſe, and afterwards torturing facts into an agreement therewith.

The ſound philoſopher begins with laying in his ſtock of facts. With theſe, by repeated and accurate obſervation he acquires a familiarity, guards againſt the deception of appearances, ſtudies and contemplates the ſubject in all its various forms, and modifications, traces every relation, and marks every difference, till at laſt, by a ſolid, cautious, and broad induction, he aſcends to a fact which unites them all, and which itſelf receives illuſtration and confirmation from each of them. For, when any one thing in nature is fully underſtood, it leads to the diſcovery of ſomething next and moſt intimately connected with it. From this the philoſopher is led to a ſimilar conſideration of a third, proceeding as it were from link to link in one common chain, till he reaches

the

the higheſt ; or he goes on, as it were, from the ſeveral points in the circumference of a circle where the radii terminate, along each radius, till he arrives at the point in which they all meet, conſtituting the centre.

This ultimate fact, at which he at length arrives, is his common cauſe, the fundamental propoſition to or from which all his reaſonings flow, and the baſis on which the whole ſuperſtructure of his doctrine reſts. Still however, he regards this as a fact only univerſal indeed with reſpect to his ſubject, but ſubordinate to other facts in the great chain of which it is only a link, and which according as they ſtand higher or lower in the ſeries, act as cauſe or effect on each other.

Finding that this fact connects all the reſt, and explains all the phenomena, he admits it as the only cauſe which a philoſopher ought to regard. Far from bewildering himſelf in vain and fruitleſs ſpeculations with reſpect to the nature of this

this common cauſe, conſidered abſtractly, and as it were, in itſelf in its mode of acting, and ſo forth, his great care and attention is to aſcertain its exiſtence, and get a full and complete acquaintance with the mutual and permanent relations which ſubſiſt between it and the effects.

Thus far he treads on known and firm ground. Here he ſtops, and keeps himſelf on ſure ground againſt the wanderings of fanciful explanation.

The pure ſtudy of nature is always ſimple, clear, and ſatisfactory, while on the contrary every diviation from it, leads but to a wilderneſs of error and inextricable perplexity. The light ariſing from the former, and the darkneſs from the latter, are in exact proportion to the reſpective progreſs of each.

The ſtudent of nature moves at firſt with caution, ſlowneſs, and circumſpection; proceeding afterwards with freedom, firmneſs, and eaſe, in pro-

proportion to the illumination encreaſing around him. And has been compared to a traveller, beginning his journey with the earlieſt dawn of day*.

The flights of an heated imagination unreſtrained by reflection, and a ſtrict regard to fact, may produce an evaneſcent temporary gratification; but the diſcovery of truth alone, can yield that moſt pure and exquiſite ſatisfaction, that ſolid and permanent pleaſure, which muſt ever ſucceed, to ſucceſs, in any important philoſophical inveſtigation.

The former is the ravings and intoxication of miſguided ſpeculation, but the latter only can afford a rational and ſound delight.

The former is but a ſhadowy, unſubſtantial joy, a mental titillation, a paroxyſm of exultation which muſt unavoidably be ſucceded by diſmay

* Vide Brown on Phyſic.

and

and regret, on the firſt diſcovery of its deluſive cauſe.

How widely, different from this, the pleaſure afforded to Pythogoras on his diſcovery of the 47th problem of the firſt book of Euclid ; or that of Lord Naper upon his diſcovery of the logarithms ; or the ſerene and ſolid ſatisfaction of mind which Sir Iſaac Newton experienced on finding his fundamental principle apply to the whole phenomena of his great and extenſive ſubject, producing a ſcientific body of knowledge, which a learned author before quoted, calls " The " ſcience of the motion of all the great bodies in " the ſolar ſyſtem, and probably in all the ſyſ- " tems of the univerſe." Illuſtrious name ! Irrefragable proof of man's vaſt genius, and the ſoaring ſoul !

The great buſineſs of a true philoſopher, is to encreaſe the number, and improve the knowledge of uſeful and important facts, and at the ſame time

time to render them ſtill more beneficial and ſubſervient to human happineſs, while the falſe philoſopher, deeming this employment below his attention, or diſcouraged with a labour too tedious and arduous for his ſtock of patience and induſtry, as perhaps wholly ignorant of the only proper method of proſecuting philoſophical enquiry, ruſhes onward to the ultimate end of his object, little ſtudious of the beſt means of attaining it.

Inſtead therefore, of labouring by obſervation and experiment, to enlarge the number of ſolid and uſeful facts, from which alone, by juſt and careful induction, the laws of nature in any of her departments can be aſcertained; his vain attempt is to diſcover the abſtract nature, the mode of operation, the hidden cauſe of the fact, which his author had taken for his common connecting cauſe, and which from the limited nature of the human faculties he had been obliged to conſider as an ultimate fact, or as a law of nature, of which

no

no cauſe more general than itſelf could be aſſigned.

Finding, therefore in the great chain of cauſe and effect, nothing more general, and impelled by an avidity inherent in the human mind, of preſſing forward to the attainment of knowledge beyond its power, he at once plunges himſelf into an ocean of endleſs hypotheſis, and thereby brings reproach, in the very principles on which he reſts it, on the doctrine or branch of knowledge, which it was his intention to improve.

Before the method of philoſophizing by induction was known, the hypotheſes of philoſophers were wild, fanciful, and ridiculous. They had recourſe to æther, occult qualities, and other imaginary cauſes, in order to explain the various phenomena of nature: but ſince the time of the great Lord Verulam, who may be deemed the parent of genuine philoſophy, a contrary courſe has happily been followed.

He convinced the world, that all knowledge muſt be derived from experiment and obſervation; and that every attempt to inveſtigate cauſes by any other means muſt eventually prove unſucceſsful. Since his time, the beſt philoſophers have followed the path which he pointed out. Boyle, Locke, Newton, Hales, and a few others, in little more than one century, improved and extended ſcience far beyond what the accumulated force of all the preceding philoſophers, even perhaps from the creation, had been able to effectuate.

Dean Swift ſeems to explain in the moſt ſatisfactory manner, that propenſity in the human mind which prompts us to attempt the ſolution of things eventually beyond our reach.

"Let us examine ſays he, the great introducers "of new ſchemes in philoſophy, and ſearch till we "can find from what faculty of the ſoul the diſ-"poſition ariſes in mortal man, of taking it into

"his

" his head to advance new ſyſtems, with ſuch an
" eager zeal, in things agreed on all hands *impoſſi-*
" *ble* to be known ; from what ſeeds this diſpo-
" ſition ſprings, and to what quality of human
" nature theſe grand innovators have been in-
" debted for their number of diſciples ; becauſe
" it is plain, that ſeveral of the chief among them,
" both *ancient* and *modern* were uſually miſtaken by
" their adverſaries, and indeed by all except their
" own followers, to have been perſons crazed, or
" out of their wits ; having generally proceeded
" in the common courſe of their words and acti-
" ons, by a method very different from the vul-
" gar dictates of unrefined reaſon, agreeing for
" the moſt part, in their ſeveral models, with their
" preſent undoubted ſucceſſors in the *academy of*
" *modern bedlam.* Of this kind were *Epicurus*, *Di-*
" *ogenes*, *Apollonius*, *Lucretius*, *Paracelſus*, *De Cartes*
" and others ; who, if they were now in this
" world, tied faſt, and ſeparated from their fol-
" lowers would, in this *undiſtinguiſhing* age, incur
" manifeſt danger of *phlebotomy*, and *whips*, and

chains

" *chains*, and *dark chambers*, and *ſtraw*. For what " man, in the natural ſtate or courſe of thinking, " did ever conceive it in his power to reduce the " notions of all makind exactly to the ſame breadth, " and length, with his own ? Yet this is the firſt " *humble* and *civil* deſign in all innovations in the " empire of reaſon. Now, I would gladly be in- " formed, how it is poſſible to account for ſuch " imaginations as theſe in particular men, with- " out recourſe to my *phenomena* of vapours (i. e. " æther) aſcending from the lower faculties to " overſhadow the brain, and there diſtilling into " conception, for which the narrowneſs of our mo- " ther-tongue has not yet aſſigned any other name " beſides that of *madneſs* or *phrenzy*. Let us there- " fore now conjecture how it comes to paſs that " none of theſe great projectors do ever fail pro- " viding themſelves and their notions with a " number of *implicit diſciples* ; and I think the rea- " ſon is eaſy to be aſſigned.—For there is a pecu- " liar ſtring in the harmony of human under- " ſtanding, which in ſeveral individuals, is exactly

" of

"of the ſame tuning. This if you can dextrouſly "*ſcrew* up to its right key, and then *ſtrike gently* "upon it, whenever you have the good fortune to "light among thoſe of the *ſame pitch*, they will, "by a ſecret neceſſary ſympathy, ſtrike exactly at "the ſame time. And in this one circumſtance "lies all the *skill* or *luck* of the matter: for if "you chance to jar the ſtring, among thoſe who "are either above or below your own height, in- "ſtead of ſubſcribing to your doctrine, they will "*tie you faſt*, call you *mad*, and feed you with "*bread* and *water*. It is therefore a point of the "niceſt conduct, to diſtinguiſh and adapt this "noble talent with reſpect to the difference of "*perſons* and of *times*.—For, to ſpeak a bold truth, "it is a fatal miſcarriage ſo ill to order affairs as "to paſs for a *fool* in one company, while in "another you might be treated as a *philoſo-* "*pher*."

From what we have already obſerved, it would ſeem to be obviouſly inferred, that an accurate know-

knowledge of the phenomena is the only basis on which convictive reasonings, satisfactory explanations, and sound theories can be established. Analogical arguments present themselves readily to a warm imagination, whilst those more decisive ones arising from experiment, can only be obtained by labour and painful attention. Hence even in the most important subjects the former are substituted in place of the latter, and after the most beautiful system has been formed, some paltry little fact is discovered, which overthrows the whole, and turns its fabricator into ridicule. If analogy, next to experiment, be in philosophical investigation the surest guide, it must always influence the judgement in proportion to the strength of the resemblance, and the number of circumstances in which similarity is found. Hence, it is not without reason that we are backward in believing what appears to us contrary to the general phenomena of nature ; but it is the duty of every lover of truth not to suffer himself to be so much actuated by that strong propensity, which in-

induces us to refer all knowledge to certain principles, as to ſuppoſe the laws of nature fewer and more ſimple than they really are. From this impatient deſire of generalizing has ſprung the too haſty reduction of ſcience into ſyſtem, which is perhaps one of the chief cauſes that have retarded the advancement of natural knowledge; for though on a ſuperficial ſurvey of the works of nature, ſhe may ſeem to have uniformly operated on the ſame plan, yet when we contemplate her with more attention and inveſtigate with more accuracy the mode and ſyſtem of her operations, we are then no leſs aſtoniſhed at the variety of the deſign, than at the multiplicity of the means of execution---

"And every view convincing marks impart,
"Of perfect wiſdom and ſtupendous art!

The antients expreſſed leſs aſtoniſhment than we do at the facts which they could not explain.

They were convinced, that man can only perceive a few of the moſt obvious ſprings employed by

by nature in the execution of her various deſigns, and therefore pronounced it preſumptuous in him to think of limiting her to a definite number of principles of action. But theſe ſages carried their circumſpection and diffidence to an improper length, for by thus diſcouraging an active ſpirit of enquiry they effectually checked the progreſs of natural ſcience. It is of the utmoſt importance in philoſophy to aſcertain, as accurately as poſſible the more general powers in nature, and to determine their cauſes, and trace their conſequences; for as the phenomena of nature are infinite, and the faculties of the human mind, particularly the memory, limited, when theſe phenomena are conſidered as unconnected with other facts, they convey but little inſtruction. The infinite is not the object of ſcience, and therefore till the laws of nature are known, by a careful obſervation of individuals, and an accurate induction from them, no progreſs can be made in natural philoſophy. Hence the neceſſity of collecting and connecting correſponding facts, and the advantage of reducing them

them to certain general principles, and of applying theſe to account for other phenomena; for thus by a ſlow and cautious induction we may advance to a knowledge of the moſt general laws that regulate the ſyſtem of nature. But though we be warranted to conſider all the phenomena that we find connected with theſe general laws, and manifeſtly depending upon them as ſo many facts explained, ſo many truths known and underſtood, yet we ought not to overlook ſuch phenomena, as are not reducible to theſe general principles, but ſhould view them as ſimple and ſeparate facts, and treaſure them up till a more enlarged experience, and more accurate obſervation lead us to the diſcovery of the powers of nature, to which they ſhould be referred.

In the courſe of the following ſheets we have uniformly endeavoured to adhere as cloſely as poſſible to theſe principles, and the matter though arranged in a ſcattered and deſultory manner is, we truſt, pregnant with many important facts,

each deriving their origin from a different author without ever having been collected into one general point of view.

A conſiderable part of the materials which have compoſed this work, were originally collected as notes, in my peruſal of different authors, without the moſt diſtant idea of publication; but finding them encreaſe very conſiderably both as to number and importance, I attempted their arrangement in as accurate and connected a manner as the numerous avocations of public practice would allow; how far I have ſucceeded does not become me to judge;---with diffidence I ſubmit them to the public, and requeſting only that portion of indulgence which is ever due to a laudable inclination.

I am not unaware of the difficulties which perhaps every young author muſt encounter, eſpecially in a firſt publication, and which are ſufficient to damp the ardour even of the moſt active genius.

Cri-

Criticiſm, as the bird of prey, lays wait eſpecially for the diſcovery of error in the *young*; ſatire prepares its keeneſt ſhafts; the merits of the work, if it has any ſuch, are not unfrequently overlooked, and its defects as ſedulouſly held forth to the eyes of the world.

Such is too frequently the fate of a firſt production, unleſs it is brought forward to public notice, by the recommendatory influence of ſome great authority, or ſupported by a ſanction which may command reſpect. I am conſcious that many imperfections will be found to exiſt in the arrangement of the ſubject matter of this work, and no leſs ſenſible, that, in all probability it contains a too plentiful harveſt of errors, which may no doubt afford ample ſcope for *puny* criticiſm; whilſt I chear myſelf with the hope, that the liberal critic, and the *ſtudent* in medical philoſophy, will find ſeveral difficulties cleared up, and many important facts taken notice of, which were before wanting, or not generally underſtood, and which may not prove altogether unacceptable.

Should

Should the public favour me with their approbation, and not frown upon my undertaking; inſtead of repining at the want of ſome compendious ſyſtem of medical knowledge, I ſhall endeavour to remedy it, to the beſt of ſuch abilities as I poſſeſs, by preſenting it with a ſyſtem of medical ſcience compiled from the works of the moſt eminent and approved authors, which, though it may not have to boaſt of much originality, ſhall at leaſt evince the candour of a genuine eclectic. In the mean time, my requeſt from the learned of time, and the ripened of ages, is this,---" Wherever there ſhall occur an omiſſion or error, cover it with the mantle of generoſity, and hold the pen of correction running over it."

A TREA-

1813
SCHOOL OF MEDICINE

A

TREATISE on the BLOOD.

By the blood, ſome have underſtood not only the fluids in the veins and arteries, but likewiſe that in the lymphatics, nerves, and every other veſſel of the body, becauſe they ſuppoſed all their contents to be parts of the blood ſeparated from it, by the force of the heart; and many of them return to it again after the performance of their deſtined office. And in this acceptation it has been taken in the calculations of its quantities and velocities, in the human body. But theſe muſt be very erroneous, ſince they will always vary in degrees, according to the different temperaments, ſexes and ages, and the different quantities of action in each.

Hence

Hence it appears a difficult matter to determine with any degree of accuracy what proportion the fluids of an animal body, bear to the ſolids; or what proportion the ſum of all the moſt minute arteries bear to the aorta; without which I ſhould think we can neither determine the comparative velocity of the blood moving in the different veſſels, nor the quantity of blood in any animal body, nor the time in which the whole maſs of blood, or a quantity equal to the whole maſs, is flowing through the heart. Yet as it is often requiſite to draw blood in the practice of medicine and again to repeat it, it has been ſuppoſed neceſſary to know the quantity of blood contained in an animal body, in order to proportion the quantity, at any time to be taken away, to the ſize and other particular circumſtances of the patient.

Various methods have been taken by different Phyſiologiſts to aſcertain this: as the weighing an animal, and bleeding it to death, then ſubtracting the weight of the blood from that of the whole animal

animal. Dr. Haller bled a horſe to the quantity of twenty eight pounds before he died; and another of much the ſame ſize loſt forty four pounds before he was exhauſted. Hence it is obvious this method muſt be very fallacious and uncertain, as the animal dies long before all the blood is drawn away; for on examining the body afterwards, we always find a quantity of blood in *ſome* of the veſſels.

Others have endeavoured to determine this point by collecting and comparing different caſes of hæmorrhagy. We have an inſtance of a perſon loſing twenty-nine pounds of blood in twenty-four hours by vomiting---Sanctorious mentions an inſtance of a man loſing forty pounds of blood in four days by a naſal hæmorrhage, and another Author relates the caſe of one who loſt ſeventy-five pounds of blood in ten days by the piles.

The exhauſtion depends more on the ſtate of the veſſels

veſſels and the manner in which the blood is diſcharged, than on the quantity---for one pound of blood loſt in five minutes will exhauſt an animal more, than two pounds taken away in two hours, as in proportion to the rapidity with which the blood flows the animal will be ſooner or later exhauſted : for it muſt be obvious to every one that (cæteris paribus) the evacuation of blood from a large veſſel near the heart will deſtroy a perſon ſooner, than when coming from a ſmall veſſel at a greater diſtance from the heart.—The momentum and velocity of the blood being proportionably more conſiderable in the larger veſſels.

If the ventricles of the heart hold five ounces of blood, and they are filled and emptied every ſyſtole and diaſtole ; of which there are many cogent proofs : and if eighty pulſes in a minute be allowed to be a common number, there then flows twenty-five pounds of blood through each ventricle of the heart in a minute. Dr. Keil has ſhewn that the ſum of all the fluids, exceed that of the ſolids,

and

and yet the quantity of blood which all the *viſible* arteries of a man will contain, does not exceed four pounds; and if we may ſuppoſe all the veins, including the ſyſtem of the vena portæ, held four times as much*, the whole then that the viſible veſſels *can* contain is not more than twenty pounds, but the whole that they *do* contain, is very little more than the veins themſelves are capable of containing, as is evident from the arteries being always found nearly empty in dead bodies.

But how much the arteries and veins contain† I know of no means whereby to form a deciſive judgement; unleſs we know what proportions theſe veſſels bear to thoſe which carry the mutritious juices and ſerum without the red globules of

* Haller has come nearer the truth in this proportion, by allowing four parts to the arteries, and nine to the veins.

† I mean thoſe which carry a compound fluid, ſuch as is found in the larger veſſels.

the

the blood. Cæteris paribus, is not the velocity of the blood and the neceſſity of taking food in all animals proportionable to their quantities of action? If ſo, we may readily underſtand how thoſe animals which uſe no exerciſe and whoſe blood moves extremely ſlow in the winter, can ſubſiſt without any freſh ſupply of food, while others, which uſe a little more exerciſe, require a proportionably greater quantity of nutritious aliment; and thoſe again, which uſe equal exerciſe winter and ſummer, require equal quantities of food in both ſeaſons. The purpoſe of eating and drinking being to repair what exerciſe and the motion of the blood has deſtroyed or rendered uſeleſs. And, is not the leſs velocity of the blood in ſome animals than in others the reaſon why wounds and bruiſes in thoſe animals do not ſo ſoon deſtroy life as they do in animals whoſe blood moves ſwifter?

The ſpecific gravity of the blood, according to the experiments of Mr. Boyle, is, as 1041 to 1000; but, according to thoſe of Dr. Javrin, as 1054 to 1000,

1000, as related by him in the Philoſophical Tranſactions. Both Mr. Boyle's and Dr. Javrin's experiments might be accurate, though they differ; as its ſpecific gravity varies in different, or even in the ſame, amimals at different times, according to the proportion of its component parts, which have different ſpecific gravities varying from each other, as the red globules are heavier than either the gelatinous lymph or ſerum, in proportion to the quantity of ferruginous matter they contain.

The blood is the moſt important and the moſt impenetrable of the recrementitious humours: it is the ſource, and, as it were, the focus of all the other animal fluids. Though many of them are not to be found originally in the blood, they having undergone very conſiderable alterations in the courſe of their ſecretion, according to the ſpecific action of their peculiar ſecretory organs. Perhaps ſome combinations of which we are unacquainted, take place in theſe veſſels. Many Phyſicians, and more particularly Mr. Bordeu, conſidered

ſidered it as a kind of fluid fleſh, and as a compound of all the other animal humours ; and though this opinion has not been proved by any well atteſted facts, yet it is by ſome ſuppoſed to be highly probable.

Though we have hitherto failed in demonſtrating the exiſtence of many of thoſe ſecretions *uncombined* in the maſs of blood ; yet we are not raſhly to infer that theſe can claim no origin from it, becauſe experiments have not hitherto ſucceeded in ſeparating them wholly from their different combinations. The operations of nature are in many inſtances very obſcure, and though our predeceſſors have not hitherto been ſo fortunate as to reſolve the myſtery, yet ſhe may be more indulgent to ſome future favourite. We may naturally ſuppoſe ſhe would not exhauſt her enigmatic ſtore on the preſent race, to the prejudice of our ſucceſſors, and thereby plunge ſucceſſive generations into a ſtate of inactivity and indolence. No, the capricious dame favours not ſuch

fatal

fatal partiality; on the contrary, we find the reſolution of almoſt every problem, leads but to others, perhaps ſtill more obſcure.

The blood differs very conſiderably, according to the viſcera which contain it, and the regions through which it paſſes; it is not, for inſtance, the ſame in the arteries and in the veins, in the ſtomach and in the region of the liver, in the ſpleen and in the kidneys; in the muſcles and in the glands, &c.

When we conſider the blood with reſpect to the whole animal kingdom, we may obſerve that it varies very remarkably in different animals, and in the different ſpecies of the ſame animal; and even, as I have before obſerved, in the ſame individual at different times, with regard to colour, ſmell, conſiſtence, and more eſpecially temperature. This laſt property is the moſt important, and appears from many well grounded arguments to depend conjointly on reſpiration and circulation.

The blood of man, quadrupeds, and birds, is hotter than the medium they inhabit, being more than the mean degree of atmoſpheric heat, but leſs than the greateſt—they are therefore called animals with warm blood—In fiſhes and reptiles it comes pretty near the temperature of the medium they inhabit; from which they are called animals with cold blood. It is probable that differences equally conſiderable would be found to obtain in all the other properties of this fluid, and more eſpecially in its chemical qualities and characters, if the blood of all animals were properly examined. Dr. Wrisberg, of Gottingen, ſays that daily experience evinces that the blood of man to which our attention is more particularly directed, varies according to age, ſex, temperament, ſtate of health of the individual, motion or reſt of body, ſtate of mind, climate, kind of life, weather, meat and drink, and the various ſpecies and violence of diſeaſes*.

* See Profeſſor Wriſberg's edition of Haller's Phyſiology.

In

In infancy, in the female ſex, and in conſumptive perſons it is more pale and thin; in robuſt and healthy men, it is thicker, of a deeper colour, inclining to black, and of a much more ſaline taſte, than in ſuch as are weak, and feed on aliments which afford but very little nouriſhment, and in whom it is generally of a yellowiſh colour.

That its degree of heat may be ſomewhat augmented by an increaſe of heat in the atmoſphere, is moſt certain; but it does not riſe to the greateſt pitch of ſummer heat. We can live in a much greater heat than that of the warmeſt ſummer, as is proved by perſons employed in ſugar houſes, melting furnaces, by mowers, and the uſe of ſtoves in Finland and in Ruſſia; as alſo by ſome late experiments of Fordyce, Blagden, Hunter and Dobſon. The natural heat of the blood is ſometimes ſo diminiſhed in an intenſe cold, that in a perſon froſtbitten, but not dead, Fahrenheit's thermometer would not riſe above 76°, though applied to the armpits, mouth, groins, and even the vagina.

That

That the matter of heat is inherent in the blood alone, and thereby transfuſed over the ſyſtem; is rendered ſufficiently probable from different phenomena; for the heat of the body is diminiſhed by hæmorrhagy in proportion to the quantity of blood loſt, or when the flow of blood is intercepted by ligature or compreſſion from reaching the joints, and the heat returns when the parts are reſtored to their natural ſtate. This would ſeem to be confirmed by a very general obſervation that when the powers of life are brought very low, and vigour is wanted to carry on the uſual functions, the ſanguiferous ſyſtem becomes affected in the moſt ſenſible manner, and its action being no longer able to propel the blood to thoſe parts of the machine which are moſt diſtant from the heart, their temperature begins to decreaſe, and continues to diminiſh in proportion as the circulation declines. Hence it is uſual to judge of the approach of death by the coldneſs of the extremities; for notwithſtanding one or two ſeeming exceptions, it is an incontrovertible truth, that animated

mated bodies loſe heat in a given temperature of air, as faſt as any unorganized matter, of the ſame bulk, of a texture any way ſimilar, and heated to the ſame degree. In ſhort ſo very numerous and ſtriking are the facts which evince the connection between the ſtate of motion of the ſanguiferous ſyſtem, and the temperature of the body, that no doubt can be juſtly entertained of the latter being in a ſecondary manner, at leaſt, the effect of the former; for no ſooner has the circulation taken place, than the temperature falls or riſes, according as the motion of the blood is encreaſed or diminiſhed. Of this we have given the cleareſt evidence in the caſe of dying perſons.

It was the opinion of the late learned Lord Bacon, that no vegetable, any more than the moſt inorganic matter, is poſſeſſed of a degree of heat beyond that of the ſurrounding medium, and he expreſſes himſelf to this effect in the following terms " In vegetabilibus et plantis mullus repe-
" ritur caloris gradus neque in lachrymis ipſo-
" rum

"rum, neque in medullis recenter apertis." But, by the experiments of Mr. John Hunter, it would appear that *living plants* have a power of reſiſting, for a certain time, the communication of cold, or at leaſt that they are longer in freezing than *dead* vegetables*. If this be really the caſe, as I doubt not it is, Lord Bacon's opinion muſt fall to the ground, and, conſequently, all concluſions deduced therefrom.

One of the moſt remarkable phenomena of *animal heat* is the uniformity which it is obſerved to maintain under the greateſt irregularity of ſize, inſomuch that we cannot perceive any difference to take place from age, ſex, ſize, or temperament. Dr. Hean (in his Ralio Medendi) has rendered this ſufficiently clear with reſpect to man, by a courſe of accurate experiments on ſubjects of both ſexes, from the earlieſt infancy, to extreme old age: and, if we may be allowed to reaſon from

* Vide Philoſophical Tranſactions, Vol. 65.

and

analogy, we may ſuppoſe that the ſame uniformity of temperature extends to all the more perfect tribes of animals. Before the time of the immortal *Harvey*, Phyſiologiſts were of opinion that the ſpecific heat of ſome parts of the body, was greater than that of others, but *Malphighi*, in his poſthumous works, affirms that it is uniformly the ſame throughout the whole body. That it is *always* ſo, cannot poſſibly be admitted by any one who is at all acquainted with the phenomena of inflammation; and that it is in *general* the caſe ſeems very dubious, from the following experiment, which was inſtituted in order to aſcertain the different degrees of heat between arterial and venous blood. Having procured two dogs of the ſame age and temperature, I divided the carotid artery of one and immediately applied a thermometer of very extenſive range to the ſtream, the mercury roſe to 97° ¼ and in the courſe of ten ſeconds fell to 96° ¼—I then divided the jugular vein of the other, and in like manner applied the thermometer to the ſtream, but the mercury only

roſe

roſe to *ſomewhat* above 96°—In this experiment I could not help remarking the different quantities of time required, for the coagulation of the blood. The *arterial blood*, though in much the ſame quantity and ſtanding in the ſame place and temperature with the venous, was not perfectly coagulated, till *upwards of three minutes* after the proceſs of coagulation in the *venous* was completed*.

That the *matter of heat* is taken in by reſpiration ſeems evident from the reſult of various experiments, as well as from accurate obſervation of its natural phenomena; for I have had frequent opportunities of obſerving that in proportion as reſpiration was more or leſs free, ſo would be the

* It is very probable that a conſiderable portion of the caloric principle of vital air, or *oxyginous gaz* is ſeparated from arterial blood, previous to the bloods circulating through the *veins*.—Hence may ariſe proportionate variations in their quantities of *heat*—But of this and other differences we ſhall have occaſion to ſpeak hereafter.

ſpecific

ſpecific heat of the animal, and that both theſe were intimately connected with the degree of perfection in the ſtate of the animal. That there is an intimate connection between the *colour* and the *heat* of the blood ſeems evident from what Haller ſays in his Element. Phyſiolog. that the blood of fiſhes, has neither heat nor denſity, and but very little craſſamentum ; in this aſſertion he is ſupported by Lewenhoeck's Microſcopical Experiments ; and, I might add to this, that thoſe which are deſtitute of gills, have their fluids as tranſparent as the element in which they live, and are nearly of the ſame temperature ; of this tribe are many of the ſpecies of ſhell fiſh, as oyſters, cockles, &c.

Whilſt the circulation of the blood continues vigorous and unimpaired, external circumſtances produce little or no change in the temperature of the body ; but as ſoon as the motion of the heart ceaſes, and the blood has begun to ſtagnate in its veſſels the abſence of the generating cauſe of heat

becomes manifeſt, and the exanimated maſs now ſinks to the temperature of the ſurrounding bodies.

It hath been imagined by many Phyſiologiſts that animal heat was produced by mechanical means; in oppoſition to which *De Haen** relates, as unanſwerable objections to its mechanical generation, two caſes which fell within his own obſervation. In the one he found the temperature of his patient, which during the courſe of an inflammatory fever had never riſen above 103°, ſtood at the time he expired, and for two minutes after at 106°. The heat of the other, who was dying of a lingering diſtemper, roſe in the laſt agony from 100 to 101° and continued there ſtationary for two hours, and even at the expiration of fifteen hours had only fallen to 85° though the ſurrounding medium did not exceed 60°.

I perfectly coincide with *De Haen* that thoſe

* Ratio Medendi, Vol. 1ſt. and 2nd.

cauſes

cauſes are utterly inexplicable on mechanical principles, and have only to obſerve, that the vital principle is not always extinguiſhed immediately on the ceaſing of reſpiration as is evident from the records of the Humane Society, through the happy inſtitution of which the vital and natural functions of many have been called into action a conſiderable time after *apparent* death.

It was ſuppoſed by Vanhelmont, Sylvius, and other chymico phyſiologiſts that animal heat was the reſult of *Chymical Mixture* taking place in ſome part of the alimentary canal. Others that acids, taken into the ſyſtem, met with alkalies which in their union generated heat. Thoſe however were mere conjectures unſupported by facts: and did we even admit theſe ſuppoſitions ſo ſtated in their full extent; ſtill would they be found inſufficient to account for the ſtability of animal heat in different climates and ſeaſons; its equability all over the body (if ſuch equability exiſt) when in health; its partial encreaſe in topical inflammation;

flammation ; or ſcarcely, indeed, for any one phenomena attending its production.

Putrifactive fermentation has been imagined to produce heat ; but every argument that can be adduced in favour of that hypotheſis muſt at once be overturned by the conſideration of this obvious fact. That heat is far more conſiderable in a living than in a dead body* ; and no rational Phyſiologiſt will deny that the putrid fermentation goes on more rapidly in the latter than in the former. Others again have ſuppoſed this principle to be the effect of *mechanical attrition*†, but in order to refute this it will be ſufficient only to remark that the conquaſſation of fluids does not produce heat, but on the contrary makes them

* " Si a putredine calor naſcaretur cadaver caleret poſt mortem, et febri torqueretur ardentius quam dum, viveret." *Helmont.* De Febr. Cap. I.

† See Dr. Martin Edn. Med. Eſſays, Vol. 3—Dr. Douglas and many others.

loſe

loſe that which they might previouſly poſſeſs. And the circulation of the blood through its canals, is ſtrictly no more than the action of fluid upon fluid, and no one will aver that fluids are either hard or dry ; two conditions abſolutely neceſſary to the mechanical production of heat. Dr. Cullen imagined the different degrees of heat in different animals to be owing to the difference of the vital principle*. But what juſt grounds have we to imagine the principle of life different in different animals ? Or how are we to conceive that the ſame degree of motion ſhould in one claſs of animals always produce a certain degree of heat; and in another claſs as uniformly a different ? Dr. Cullen's hypotheſis therefore unſupported by any well atteſted facts, muſt one day, like thoſe of his predeceſſors, be conſigned to oblivion.

Some again have imagined animal heat to be inherent in the nervous ſyſtem, but Mr. John Hun-

* Vide Inſtitut. Med. p. 224.

ter

ter, ſeems wholly to have refuted that opinion*.

It has been ſuppoſed that the ſubtle principle, by chemiſts called *phlogiſton* which they imagined to enter into the compoſition of every natural body, was by the action of the vaſcular ſyſtem gradually evolved through every part of the animal machine, and that during this evolution heat was generated‡, but as the exiſtence of ſuch a principle, cannot by any plauſible facts be eſtabliſhed, this theory muſt of conſequence be thrown aſide. This hypotheſis was taught by Dr. Duncan; and one very ſimilar by Dr. Franklin, as alſo by Dr. Mortimer.†

Gaubins, imagining the red globules to be of an oily nature, ſuppoſes them beſt calculated for the generation of animal heat. Haller, on the other

* See Philoſophical Tranſactions Vol. 66.

‡ See Leſlie on Animal Heat.

† See Philoſoph. Tranſact. Vol, 45.

hand,

hand, conſiders the iron preſent in the blood as neceſſary to the production of heat: however widely theſe two laſt authors differ in this matter, yet they agree in aſcribing the heat of animals and the colour of their blood to one and the ſame cauſe; for while Dr. Haller ſuppoſes both to depend on the quantity of iron contained in the blood. Profeſſor Gaubins as confidently imputes them to a quantity of phlogiſton (as he calls it) preſent in that fluid, as appears from the following, and many other paſſages in his works. "Rubri ſanguinis exceſſus cum phlogiſton in "ſanguine abundans notet, quavis occaſione no-"civa, caloris augmenta immodicas expanſiones "inflammationes creat."—Patholog.

It was the opinion of Dr. Black, that, as not only breathing animals, are of all others the warmeſt, but alſo as there ſubſiſts ſo cloſe a connection between the ſtate of reſpiration and the degree of heat in animals, that they appear to be in an exact proportion to one another; animal heat

heat depended on reſpiration, that it was all generated in the lungs by the action of the air, upon the principle of inflammability, in a manner little diſſimilar to what occurs in actual inflammation; and that it is thence diffuſed by means of the circulation through the reſt of the vital ſyſtem*.

Of all the various *theories* I have here ſtated, that of Dr. Black ſeems to come neareſt the truth; and I am inclined to think, that if the laſt mentioned author had purſued his enquiry relative to latent heat, and the generation of carbonic acid, but a very little further, he would have had the honour of diſcovering firſt, what the French chemiſts are now beginning to eſtabliſh.

To many it may, no doubt, appear foreign to the general tenour of this work, that I ſhould have entered ſo fully on this ſubject; but, conſidering its very great importance in the animal

* See Maclurg Diſſert. Phyſ. de Calore. Edinburg. 1772.

œconomy,

œconomy, and the many obſtinate controverſies it has given riſe to*; I thought it a duty incumbent on me to ſketch out as conciſely as I could, the principal theories, that have at different times been advanced, for the purpoſe of explaining this curious phenomenon. Thus, the reader will be left to judge for himſelf, and for a more full explanation of the different hypotheſes, he is refered to the authors above quoted. In the mean time I ſhall attempt, in the ſame brief manner, to account for this phenomenon, on the principles which appear to me beſt grounded; and which, I believe, have already met with the attention of many enlightened philoſophers.

We have already remarked, that animal heat and reſpiration were moſt intimately connected; and it is upon this principle we go, in the deduction of the following theory.

* The *expence* incurred by the *purchaſe* of ſo many authors as have written on this ſubject, would, no doubt with many, be a weighty conſideration.

Atmoſpheric air, according to Mr. Lavoiſier, is compoſed of one part of *carbonic acid*, twenty-ſeven of vital air, or *oxygenous gaz*, and ſeventy-two of *azotic gaz*, or atmoſpheric mephitis.

The *lungs* are the organs deſtined for the important functions of reſpiration; and their mechanical ſtructure * is moſt peculiarly adapted for the purpoſe of bringing the blood into contact with the external air, and thereby affording it an opportunity of recovering from the *atmoſphere* ſuch principles as are neceſſary to the welfare of animal life, and which had been ſeparated from it in the courſe of circulation; as well as to free itſelf of ſuch matters, as are either prejudicial, or at leaſt not *neceſſary* to an healthy ſtate in the animal.

* For a deſcription of their mechaniſm, we muſt refer to anatomical authors, who have deſcribed their beautiful and varying ſtructure, in a manner equally elegant and accurate. See Monro, Winſlow, Haller, Douglas, and many others.

In

In the act of *respiration*, the external air is brought into contact with the *blood* as it passes through the lungs; and, by a change of principles, or rather by a double affinity, supplys the latter with salutary principles while the atmosphere becomes so vitiated, as to be no longer fit for the purposes of respiration.

In order to explain this, it will be necessary to remark that *oxygenous gaz* is composed of the *caloric* and *oxygenous principles*, and that the blood contains more or less of the carbonaceous principle; it is with this *carbonaceous principle* that the *oxygene* of the atmosphere unites during the act of respiration, producing *carbonic acid*, which is afterwards, either wholly or in part, carried off along with *azotic gaz* in the succeeding expiration, leaving the *caloric principle* of oxygenous gaz to be diffused through the system, in the course of circulation*.

* The inhalents on the surface of the body no doubt contribute to this effect, though by no means in so considerable a degree.

The

That hydrogene gaz is exhaled from the blood during reſpiration, and, uniting with the oxygene of the atmoſphere forms *water*, ſeems evident from the very commonly obſerved, though curious fact, of the breath of animals condenſed on glaſs, producing water, which is compoſed of the hydrogenous and oxygenous principles.

Dr. Crawford's experiments and obſervations on this ſubject are truly intereſting and ingenious, though wholly ſuperſeded by modern diſcoveries*.

From the preceding obſervations it may not be difficult to account for the deleterious conſequences which enſue from confinement in cloſe places, and more eſpecially when in conſiderable numbers as in theatres, priſons, hoſpitals and in the holds of ſhips, &c. In the latter, Dr. Trotter

* See Crawford on Animal Heat. A tract which I ſuppoſe to be in the hands of every one; and whoſe doctrines therefore it will not be neceſſary to inſert here.

has

has obſerved that they are often ſtowed ſo cloſe, that it is difficult to move without treading upon them. And ſpeaking of the apartments in an African ſlave ſhip, he ſays, "The temperature in "theſe apartments when they became crowded, "was ſometimes above 96° of Farenheit's ſcale*." He adds, "I myſelf, could never breathe there, "unleſs under the hatchway. In ſuch ſituations "it may be ſuppoſed that the ſufferings of theſe "creatures are ſometimes dreadful. Air heated "and rarified to ſuch a degree, and loaded with "animal effluvia, cannot fail of being noxious "to life; there were *certainly* inſtances where ſome "expired from *ſu ocation*, having ſhewn no pre-"vious ſigns of indiſpoſition†. During this ſeaſon "of the year" he adds "there was little rain, and "the weather was not more ſultry than is uſual "in theſe latitudes."

* Vide Trotter's obſervations on the ſcurvy, Edit. 1792, p. 54.

† Vide Dr. Trotter's evidence on the Slave Trade, before the ſelect committee of the Houſe of Commons.

That

That these effects are not always produced by numbers of individuals collected together and confined in a small compass, seems obvious from the following fact.

Out of upwards of 1600 prisoners, confined in the French prison at Forton near Gosport, the average number of sick has never exceeded 70 although they are very much crowded during the *night** ; whereas in the Regiment now doing duty there, the average of sick has been upwards of 40 for a considerable time past ; while the number of privates in the Regiment (non-effectives† included) has I believe never exceeded 471 since the time of our being called out in the month of

* They are allowed to take sufficient air and exercise in the *day*.

† I mean by non-effectives such men as do not mount guard, &c. of which class at this time there are 140, many of whom however are returned as *effective* by the commanding officer.

January

January 1793—out of which upwards of 170 men have been under my care ſince the 15th of January, 1794.

This, I think, may be accounted for in two ways. Firſt, from the *ſoldiery* being expoſed to the *night damps*, which in conſequence of ſeveral arms of the ſea and the neighbouring marſhes, are very conſiderable, and from which the *priſoners* are in a great meaſure ſecured by the priſons being ſhut up at a very early part of the evening. *Secondly*, from the *flagrant abuſes* which are ſuffered to exiſt in the recruiting of *our* Militia by which the Regiments are filled with a *motley ſet*, compoſed of *raw young boys*, *diſeaſed refugees*, and *decrepid old men*. Thus verifying the too well founded remark of the humoriſt, and inſtead of being the *pillars* do actually become the *caterpillars* of the nation*.

* A Striking, but *melancholy* inſtance of this, exiſts at this moment in the Regiment to which I belong, where inſtead of 534 *duty men* (which is the proper compliment of the

The

The blood, we have remarked, retains a portion of the *carbonic acid* which may be uſeful in the ſyſtem as an *antiſeptic*, ſince it has long been known to poſſeſs the peculiar property of preſerving animal ſubſtances, retarding their putrifaction, and even reſtoring them to a ſound and freſh ſtate, after the putrifactive proceſs has begun to take place. Hence the utility of waters impregnated with this acid, given pretty largely in putrid, or bilious fevers, in diſeaſes of the lungs, and in ſome kinds of ulcers, &c. May not a ſomewhat peculiar to *oxygene* give riſe to that principle which authors treat of under the denomination of the vitality of the blood?

In the courſe of this work we ſhall endeavour to ſhew that many conſiderable alterations in the ſyſtem take place, from the different quantities of

Regiment) we have never had more than 350, and while I am writing this, (*March 1ſt*,) there are *only* 331 duty men, 63 *wanting to complete* and 140 non-effectives.—But of this we ſhall ſpeak more fully hereafter.

oxygene

oxygene contained in the blood; and many phenomena tend to evince that this principle is of infinite importance, nay even indiſpenſibly neceſſary to the *continuance* of animal life.

A kind of volatile *vapour* or exhalation is continually flying off from the *warm blood*, which has a ſort of fœtid ſmell, intermediate between that of ſweat and urine; this vapour after collection and condenſation in convenient veſſels, is of an aqueous nature, partaking ſomewhat of an alkaline quality; and ſometimes by the ſlow return of the venous blood to the heart, theſe vapours ſtagnate in the cellular membrane, producing ædematous ſwellings in weak people. After the vapour is diſſipated, the blood of a healthy perſon congeals into a trembling ſciſſile maſs. This exhalation takes place immediately on its being drawn from the living animal, and a ſenſible vapour flies off, which Dr. Cullen calls the *halitus* of the blood, and which, being diſſipated by this exhalation, leaves the maſs ſomewhat lighter; according to

the degree of heat to which it is expoſed, the extent of ſurface influenced by the air, or different conditions of the blood at the time. It is the *ſeroſity* of the blood which is ſuppoſed to afford this ſubtile vapour, which is more pungent in carnivarous than in graminivorous animals, and even inſtances are not wanting in the annals of phyſic, in which it has proved fatal.

On chemical analyſis, Dr. Haller found it to be the ſame as the matter of perſpiration; and this indeed is what we ſhould have expected, for as neither the *halitus*, nor the matter of perſpiration are poſſeſſed of any obvious acid or alkaline qualities, their *ſenſible* properties would ſeem evidently to depend on a highly attenuated oily matter, of which the principle of inflammability ſeems to be the chief ingredient. There is at leaſt no doubt but this is the caſe with reſpect to *perſpiration*, as appears from the ſtrong ſcent that is conſtantly ſmelt after profuſe ſweats in fevers; and alſo from *dogs* being at all times able, by means of this odour,

odour, not only to diſtinguiſh one ſpecies of animal from another, but even any one *individual* from every other of the ſame ſpecies.

By this evaporation of its thin, aqueous parts, the neceſſity of frequently taking food (particularly fluids) is encreaſed, as by this evaporation the blood being naturally of a ſaline quality, acquires an acrimonious putreſcency, the irritation of which is ſaid to be the cauſe of the frequency of pulſe in fevers; and the diſſipation being encreaſed according to the heat of the body and the motion of the heart and arteries, nature ſtrenuouſly demands a recruit of the watery parts, by which the coheſive parts of the blood are ſeparated from each other, and are prevented from running together into a ſolid maſs; for drink dilutes the *coheſive diatheſis* of the blood, hinders its putrefaction and carries off by the emunctaries, ſuch particles as have already become noxious.

Hence

Hence the great uſe of diluent drinks in fevers, more eſpecially in thoſe which have a putrid tendency. And hence it is that a perſon may *ſubſiſt* for a long time without *ſolid food* provided he is properly ſupplied with *drink*; but without this laſt, life ſubſiſts but for a few days. It has however been obſerved that in ſuch as have their blood *too thin*, the globuli cohere and form moleculæ or polypi. There is an acrid and fœtid water ſometimes returned from the *foeces* into the blood; hence coſtiveneſs in fevers is hurtful, the affuſion of this matter encreaſing putrefaction.

The blood, in the healthy ſtate, when firſt drawn from the body, is *apparently* an homogenous fluid of a beautiful florid red colour, unctious to the touch, ſomewhat ſuponaceous, and of an inſipid ſaline taſte; but which, ſoon after it is ſeparated from the veſſels, is found to be an heterogenous aggregate; perhaps obſcurely organized, and which is compoſed of ſeveral parts differing much from

from each other in their chemical and phyſical properties.

By chemical analyſis the blood is found to contain many more ſubſtances than thoſe which are evident to our ſenſes from its ſimple and ſpontaneous ſeparation; all of which we ſhall examine in their proper places. But before we proceed to its analyſis, it may not be amiſs to ſay ſomewhat more concerning its phyſical properties, as colour, temperature, taſte, ſmell and peculiar conſiſtence; on which ſomething has already been offered.

By the microſcope we diſcover in the blood, red globules, which, when joined with the coagulable lymph, make that part by ſome called *cruor*, but more properly *craſſamentum*, and which, when broken, according to Lewenhoeck and Boerhaave, in their way through the ſmall paſſages, loſe their red colour, become yellow and afterwards white: ſo that, according to the Leyden Phyſician, a *red globule* is an aſſemblage of many ſmaller *white globules*

bules and derives its colour from aggregation only: but this Dr. Haller could neither obſerve nor readily admit.

Theſe red globules have been conſidered as an oily matter, thereby accounting for their globular appearance; but Dr. Cullen thinks there is no direct proof of this, alledging their ready union with and diffuſibility in water render it very improbable. That they contain a pitchy oil is doubtleſs, as may be fully proved by chemical analyſis; hence I would ask, May not the alkaline ſalts which they contain facilitate their union with aqueous menſtrua?

They have been variouſly repreſented by different microſcopical obſervers; ſome have thought them ſpherical and diviſible into a determinate number of other ſpheres, but others again have not obſerved this diviſibility; by ſome they have been ſaid to be oblate ſpheroids, or lenticular; while others again have ſuppoſed them annular;

and

and they have even been conſidered as a hollow veſſicle: hence we may infer, that microſcopical obſervations are liable to great uncertainties.

If it be queſtioned whether theſe are not lenticular particles of the ſame kind with thoſe which Lewenhoeck obſerved in fiſhes, and which have been lately diſcovered in the human ſpecies, we anſwer, that being conſcious of the difficulty attending the determination of ſo intricate a point, we chuſe rather to leave that (at leaſt for the preſent) to men of more experience and greater depth of judgment than hazard an hypotheſis, which, if it did not elucidate the ſubject, might only plunge us into greater perplexities, and from which it might be difficult to free us. Hewſon, however obſerves, that the particles are flat, like a guinea; but waving all abſtruſe theories and intricate diſquiſitions, we refer to his Treatiſe on the Blood, for their more particular deſcription.

The

The redneſs of the blood is peculiar to the globules, and depends upon theſe *only*. The intenſeneſs of their colour and the proportion they bear to the whole maſs increaſes with the ſtrength of the animal, being very conſiderably more abundant in the robuſt than in the debilitated ſtate.

Dr. Cullen ſuppoſes the variation of colour in the common maſs of blood to depend entirely on the differences of aggregation in theſe globules. Their diameter is very ſmall, not exceeding the 1-2000th of an inch; and, have been imagined by ſome anatomiſts, to change their figure into an oblong ſhape, adapted to the capacity of the veſſels through which they paſs, but which Dr. Haller could never obſerve with ſufficient certainty. Nor indeed can we readily admit of ſuch a ſuppoſition; for were this the caſe, and were the globules poſſeſſed of this peculiar *organic* power, we ſhould find them by this kind of aſſimulation, pervading every the moſt *minute* veſſels in the

the body, which no one I think has ever been able to obſerve in a *natural and healthy ſtate of the parts.*

Indeed there have been inſtances of *red blood* paſſing off by perſpiration, &c. but I would account for ſuch peculiarities by a *morbid relaxation* of the *cutaneous veſſels*, permitting ſuch parts to paſs as would not enter them in a *healthy ſtate*; or, by any increaſed afflux of the fluids to particular parts, irritating the veſſels, and thereby procuring a paſſage to the red blood; (of which we have an inſtance in inflammations of the *tunica conjunctiva* of the eye) rather than admit of ſuch peculiar organization of the red globules.

The circumambient air has no doubt conſiderable influence on theſe peculiarities, as by a diminution of its *denſity* and *preſſure*, the blood has been often known to burſt through the ſkin, or from the lungs, &c. occaſioning hæmorrhagies. Hence the impropriety of exploring the tops of *very high mountains*, on the ſummits of which the

air is ſo ſpecifically light, as (independent of the effects we have already enumerated) to be wholly unfit for the purpoſes of reſpiration*.

Theſe globules do not contain *air* as ſome have imagined, as is demonſtrable from their ſpecific weight, which either in their fluid or ſolid ſtate, is nearly an eleventh part heavier than water. They may be obtained by waſhing the craſſamentum in water, and afterwards evaporating to dryneſs, but under this proceſs they ſuffer a change of colour.

* *Very deep vallies* are equally unfavourable to health as *very high mountains*; the air in the *former* being loaded with *carbonic acid*, or fixed air, (ſimilar to that noxious vapour found in certain caverns and ſubterraneous paſſages,) and other groſs matters exhaled from the ſurface of the earth, in much more conſiderable quantities, than are to be met with in the more elevated regions of the atmoſphere; which latter abounds more eſpecially in *hydrogene gaz*. (See Fourcroy, Berkenhout, and others.)—And hence it is extremely dangerous in people of very delicate habits expoſing themſelves to any very *ſudden* and conſiderable alterations of the atmoſphere.

They

They abound moſt in the *human body* and eſpecially in the muſcles, but are not eſſential to muſcular motion, as we may readily infer from the muſcles of fiſh being *white*, and thoſe of rabbits, and ſome fowls nearly ſo.

The blood, while hot and in motion, remains conſtantly fluid; but if it be not kept fluid by the attrition of *vital circulation*, and is ſuffered to reſt in a moderate degree of cold, it takes the form of a ſolid maſs, which gradually and ſpontaneouſly ſeparates into two parts, as it likewiſe does by the addition of *alkahol*, *mineral acids*, *fermented liquors*, &c. Some Authors* have remarked that by agitation till cold, it will continue fluid. There are certain ſtates of the body no doubt, in which the coheſive powers of the fluids are conſiderably *diminiſhed* or even *deſtroyed*; but from what I have uniformly been able to obſerve, I do not heſitate to affirm

* Vide Nicholſon's Firſt Principles of Chemiſtry, p. 511.

that

that in a *diſeaſed ſtate only*, will the blood be prevented from coagulating by *mere conquaſſation*. It will coagulate by a degree of heat equal to 150° of Farenheit's ſcale; but it will not coagulate by heat* leſs than 120°. Hence Mr. Cline affirms that coagulation never takes place in fevers, obſerving that the heat in the higheſt fever never exceeds 112°: but how he could aſcertain the exact heat of the blood, while moving in its proper veſſels, and in all the varieties of conſtitution and diſeaſe, I muſt confeſs, I am at a loſs to determine.

The ſpontaneous ſeparation and caogulation of the blood frequently takes place in the laſt moments of life; it ſometimes coagulates in the veins of *living perſons*, and is found clotted in wounds of the arteries†.

* Perhaps the blood, when it has not been expoſed to the action of the air, as in drawing it from the body, may not require ſo great heat as 120° to effect its coagulation.

† In a firm healthy conſtitution as ſoon as the diſcharge of blood, which naturally accurs in every large wound, is over,

This

This is fully proved in amputations, after which, a conſiderable portion of the capacity of the arteries is obliterated by the formation of coagulum, which in time becomes perfectly organized. A very curious caſe of this nature was related to me by Mr. Eligie, formerly Surgeon with the army in Flanders, during the heat of action a man was wounded in the leg, and amputation was performed, the Surgeon had ſecured the *principal veſſels*, but, apprehenſive of being taken priſoner, he had hurried on the dreſſings and bandages in a very looſe manner, ſo that when the man was creeping to ſome adjoining buſhes in order to ſhelter himſelf, the whole of the bandage fell off, and he was under the neceſſity of covering the *ſtump* with the *ſkirts* of his *coat*,

the parts become covered with a viſcid coagulable effuſion from the now retracted arteries; but in conſtitutions of an oppoſite nature, where the ſolids are much relaxed the blood is generally in ſuch a diſſolved ſtate as to afford no ſecretion of this nature, and in order to ſupply as much as poſſible this deficiency, many artificial balſams have been applied.

yet

yet, notwithſtanding his being expoſed to the cold and rain for twenty-four hours before he was removed to the hoſpital, the man recovered and did well, without any further hæmorrhage taking place*. Trifling as this circumſtance may appear to ſome, it has ſaved the life of a ſoldier—It may do ſo again—and would induce us (independent of other cogent reaſons) to *reprobate* the man, who through motives of ſelf-intereſt, can ſtoop to rob the needy ſoldier of that *little*, which the bounty of his King hath given him; equally regardleſs of the ſoldiers ſufferings, or the *mandates of his Sovereign.*

In the veins of a living perſon, and in one dying of a fever, the blood has been ſeen, by the violence of the diſorder, changed into

* It may be remarked, that the men's cloathing in the Weſt Middleſex Regiment, in many inſtances, has not covered their loins, therefore could not afford ſo ſalutary a relief in caſe of exigence—dictum ſat, &c.

a concreted tremulous jelly throughout all the veins; and I have more than once ſeen the cavities of the arteries completely filled with it, producing thoſe concrete ſubſtances, which are found in the heart and large veſſels, and have been frequently, but erroneouſly taken for polypi†.

This diſpoſition to coagulate even in the veſſels, under particular circumſtances, as *ſyncope*, &c. affords us an uſeful practical hint in caſes of internal hæmorrhagy; as from the *lungs*, *uterus*, &c. when if the patient faints we ought not to endeavour to revive him by the application of any *volatile*, *foetid*, or *ſtimulating* medicines, as is uſually done, but rather ſuffer him to remain in a ſtate of ſyncope for the ſpace of five, ten, or even fifteen minutes, by which time the mouths of the

† Sometimes coagulable lymph may by inflammation be poured out, forming a polypus during life; but we are inclined to believe that *many* of thoſe concretions which authors have mentioned as polypi, are formed after death.

bleeding

bleeding veſſels, will be ſhut up by contraction or the formation of coagulum at their extremities.

The time the blood takes in coagulating is different according to various circumſtances in the ſtate of the individual from whence it is taken, as, in general, it coagulates ſooner in weak people than in thoſe of a contrary habit, whoſe blood does not coagulate ſo readily, but is when coagulated a much more compact maſs.

In operations I have obſerved with others, that the blood coagulates *ſooneſt* when the patient is faint and emaciated, than in a ſtrong healthy ſubject. The mode of extracting it will alſo have a conſiderable influence on its concertion.

Blood when in an inflamed ſtate is thinner, coagulates ſlower, and is, when coagulated, more firm than ordinary.

In

In general, after having ſtood for about four minutes, it begins to coagulate and extends on the ſides of the veſſels till the proceſs is completed, which is uſually the caſe in about ten minutes from its commencement. This coagulation is not entirely owing to cold or reſt, for though it be kept in motion by any mechanical means, this phenomena is not prevented, though it may perhaps require a greater length of time in taking place; nor again, is expoſure to air (though very favourable to this proceſs) abſolutely neceſſary, for when diſcharged from the veſſels into the cellular membrane it very ſoon coagulates as we frequently ſee in bruiſes, a remarkable inſtance of which came under the obſervation of Mr. Cline; A woman who had fallen from a great height, was ſent immediately to St. Thomas's hoſpital; a great extravaſation had taken place into the labia pudendi into which he made ſeveral punctures with a lancet, but no blood eſcaped, though the accident had happened but a few minutes.

Mr. Hewſon made a great number of experiments in order to determine on what cauſe the coagulation of the blood depended; he expoſed the jugular vein of a rabbit and made a ligature at each end, yet the blood did not coagulate, though kept in perfect reſt, but by mixing air with the blood by means of a third ligature, it coagulated in fifteen minutes, which clearly demonſtrates, that air has great influence in producing this change. Again, on applying a ligature on the arm and making the puncture an hour afterwards, blood will flow out perfectly fluid. Hence it would ſeem probable that the blood-veſſels in ſome unknown manner preſerve the blood in a ſtate of fluidity, for while in the veſſels and in a healthy ſtate, it will not coagulate, though expoſed to circumſtances favourable to that change. In ſome inſtances it has been found incapable of coagulating without the admixture of ſome *extraneous* ſubſtances. This, Dr Hunter particularly remarked in game that were hunted to death, as deer, &c. His experiments and obſervations were

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rendered much more concluſive, by a man who died ſuddenly in a paſſion, being exhauſted of life by exceſſive action, it thickened a little like cream, but a perfect coagulation by no means took place, the Doctor thinks it owing to a deprivation or change of ſome of its natural qualities*.

If after blood is drawn, it is kept in a natural ſtate of heat, it more readily coagulates, but this may be prevented by the addition of neutral ſalts. This natural diſpoſition in the blood to take a concrete form, is productive of various appearances and phenomena in diſeaſes, as coagula in aneuriſms, &c. If a portion of aneuriſmal coagulum be macerated in water, it will ſeparate into ſtrata, which may be accounted for by the ſlow accumulation of coagulum in the aneuriſmal ſac; layer ſucceeding to layer, forming a laminated

* May not this ariſe from a deficiency of *oxygene* in the atmoſphere, or an exhauſtion of this principle during vio-ent exerciſe?

ſtruc-

ſtructure, which continues to encreaſe ſo long as the ſac is capable of any further diſtention.— Theſe membranous ſtrata I have obſerved both in the encyſted and diffuſed ſpecies of eneuriſm. Hence we may readily account for the *firmneſs* which ſome parts of the aneuriſmal ſac acquire, in the more advanced ſtages of the diſeaſe*. The coheſion of theſe ſtrata will be broken down by maceration, and they may then be ſeparated.

The *craſſamentum* of blood when forced from its watery parts, is inflammable; and in a *healthy ſtate* of the animal it exceeds, or at leaſt equals, the quantity of *ſerum*, which laſt, in laborious people, often occupies no more than one third of the maſs;

* It may not be unworthy of remark that, as blood-letting when not accurately performed, is perhaps the moſt frequent cauſe of this troubleſome and often fatal diſeaſe, it were to be wiſhed, practitioners in general would pay more attention to this nice and important operation.

and

and is ſometimes diminiſhed to a fourth or fifth part in fevers*.

The blood in a perfectly ſound healthy ſtate, free from putrefaction, and in a proper degree of heat, is neither *acid* nor *alkaline*, but mild and gelatinous, ſomewhat ſaltiſh to the taſte. It is however rendered acrid by diſeaſe, as in the waters of *dropſies*, which are frequently *alkaline*; and in ſome caſes it approaches very near to a ſtate of putrefaction; as in the *ſcurvy*, where it frequently becomes ſo acrid as to corrode the veſſels which contain it.

I have often remarked the ſurface of ſcorbutic ulcers overſpread with a conſiderable portion of dark, grumous blood; and it has been a general obſervation of moſt authors who have written on

* Hence the utility of diluent drinks, given copiouſly in moſt kinds of fevers, as mentioned in a former part of this treatiſe.

the

the ſubject, that the blood of *hæmorrhagies* in thoſe who were afflicted with the *ſcurvy*, was always of a more deep colour than uſual, inclining to black, and in many inſtances incapable of complete coagulation†.

That theſe peculiarities ariſe in a great meaſure from inactivity and a conſequent deprivation, or want of ſome active principle neceſſary to the welfare of the ſyſtem, ſeems evident from the remarks of Dr. Trotter, who, ſpeaking of the ſcurvy on board an *African ſlave-ſhip*, ſays "Few "of the boys had any ſcorbutic ſymptoms: none "of them were ſhakled, and by being allowed to "run about the deck, and occaſionally aſſiſt in the "duty of the ſhip their health ſeemed to be pre-"ſerved by the exerciſe*." Whereas it ſeldom

† Vide Dr. Sandifort's caſe of the *blue boy*, as related by him in the Obſervations Anatomica—Pathologicæ Lugd. Batav. 1777 from p. 11.

* Vide Trotter on the Scurvy, Edit. 1792, p. 63.

failed

failed to attack thoſe who were moſt *corpulent* and had taken the leaſt exerciſe, inſomuch that the ſame juſtly celebrated author obſerves that, "So "general was this obſervation, and ſo fully was "I confirmed of it that when a negro was becom-"ing rapidly fat, it was no difficult matter to de-"termine how ſoon he would be ſeized with the "ſcurvy." This peculiar dark colour of the blood in perſons affected with the ſcurvy, may in a great meaſure depend on the want of oxygene*, and this ſeems to be ſtill more confirmed by the colour of the blood in *conſumptive patients* being ſo univerſally oppoſite to that in the *ſcurvy*.

While a pupil at the General Hoſpital near Nottingham, I had daily opportunities of examining

* This ſuppoſition I believe firſt occured to Dr. Beddoes of Oxford, whoſe obſervations on the ſcurvy, &c. have exhibited a more valuable collection of important facts, than hath perhaps been *ever* offered to the philoſophical world in ſo ſmall a compaſs.

the

the blood of phthifical patients and found it univerſally of a *bright red*, inclining ſomewhat to *purple*, and generally exhibiting a very large portion of inflammatory cruſt when coagulated. This again differs much from the colour of the blood in perſons who, from trifling complaints or more frequently from *habitude*, have been let blood; in whom it is generally of an intermediate colour between the *very dark*, and that of a more *bright red*, than that which is uſually underſtood by the appellation of *florid**.

This difference of colour, ſeems to hold in the more ſolid parts, as I have frequently remarked when examining the bodies of ſuch as have died of ſcurvy, or phthiſis. In the former I do not remember to have ſeen *one inſtance* where the muſcles did not univerſally appear of a morbid *dark*

* It may be remarked that the blood of pregnant women, I have frequently obſerved to be *extremely dark*, though *not always* ſo.

colour;

colour; whereas in the latter I as uniformly found them of a *bright red.* Hence the impropriety of exhibiting oxygene in caſes of phthiſis as recommended by ſome; when it is more than probable that its ſuperabundance will not a little contribute to the diſeaſe.

And I am inclined to believe that a ſtill leſs quantity in the air we breath would be found in general more beneficial*. The quantity of heat diſengaged from it being ſo great, that were the atmoſphere ſurcharged with this principle, which in a *certain quantity*† is ſo eminently ſerviceable for the purpoſes of life, the circulation would be rendered *too* rapid, and the exceſs of heat become ſo conſiderable, as to produce ſymptoms equally or

* Vide Dr. Beddoes Obſervations on *Conſumptions*, &c.

† M. Lavoiſier has fixed the quantity of vital air in the atmoſphere at about 28 parts in 100—This however will vary according to ſituation.

perhaps more prejudicial than could poſſibly accrue from the want of it.

That air is contained in the fluids of the human body, I believe, is very generally allowed; and is fully proved from the phenomena exhibited by animals in an exhauſted receiver, but how it arrives there has been a matter of conſiderable diſpute, nor is it eſſential to our purpoſe, that we ſhould examine minutely into the ſubject. Many have ſuppoſed that it was introduced along with our aliments *alone*; others that it was more frequently abſorbed from the lungs in the paſſage of the blood through thoſe organs, while others again as confidently aſſert that it never comes in *contact* with the blood in the lungs. But the diſcoveries of modern philoſophers have taught us far otherwiſe;---the anatomiſt can now readily demonſtrate thoſe innumerable pores and foramina, to be obſerved along the courſe of the larynx, aſpera arteria, and bronchia; while the modern chemiſt ſpurning the ignorant ſilence of alchemy,

alchemy, and emulative of cotemporary merit, labours to cull the *genuine* phenomena of nature, rejecting the flimsy arguments of the *mere theorist*, and ever indefatigable in his researches, seems as it were by slow degrees emerging from the shades of that impenetrable darkness which, till late, was wont to be the veil of explication and of truth.

"Amicus Cicero, Amicus Plato, sed magis amicus veritas."

These mists seem already to be dispelled, and we are now convinced that upon the diversity of these pores or foramina, both with respect to number, condition, and mucus with which they may be covered, as well as the size of the respiratory organs, depends the reason why each individual connot inhale and absorb the same quantity of salubrious matter from one and the same air. Hence we may readily infer that many diseases have been supposed to originate from a vitiated or imperfect state of the atmosphere, which with greater justice might have been applied to a default in the state

of

of perfection of thoſe organs deſtined for the ſeparation of the more ſalutary principles of the atmoſphere.

The celebrated profeſſor of Gottingen* ſeems to have been aware of the connection between reſpiration and the ſtate of the blood in animals; as appears from his notes to Haller's phyſiology, where he ſays "Among the uſes of reſpiration, is "that of reſorption; by which the veſſels of the "lungs abſorb from the air inhaled in inſpiration, "not only vapours mixed with the air, but min-"gle with our humours by means of the forami-"na, ducts and proper canals, ſome other *more* "*noble parts*, conſtituting at the ſame time one of "the elements of the air." And in note 72, he ſays "If, in a few words, I might offer my opi-"nion about the air found in our bodies which "has been the baſis of ſo many diſputes, I am "perſuaded, that atmoſpheric air is a very com-

* Wriſberg.

"pound

"pound fluid, conſiſting of parts, very different "in their nature and quality; which parts, when "mixed with any primogenial fluid as a vehicle, "make the common air we inhale in inſpiration. "This primogenial fluid is perhaps, that air "which we obſerve in animals, vegetables, and "likewiſe in the earth itſelf, differing only accord- "ing to the various ſubſtances with which it is "united. If there is mixed in a due proportion "with this univerſal fluid, any elaſtic ethereal, "electric principle, or any particles not yet fully "underſtood, perhaps there will reſult ſalubrious "atmoſpheric air. But it will become infected "and noxious in various degrees, from an admix- "ture of putrefactive ſubſtances, narcotic or in- "flammable ſuffocating elements. For that rea- "ſon it ſeems to me very proper that our judge- "ment reſpecting the ſalutary or noxious quality "of the air, ſhould be directed by theſe princi- "ples; and hence it will be in our power to "correct unwholeſome air, provided we know "what qualities the air ſhould poſſeſs, as moſt

"ſuited

" ſuited to the function of reſpiration." The ſame ingenious author thought this *electric principle* (as he ſuppoſed it to be,) might influence the tone and irritability of the fibres of the body, as alſo the *cauſes* and *increaſe* of animal heat—And the diſcoveries of modern chemiſtry ſeem to warrant our opinion, in ſuppoſing the concluſions of profeſſor Wrisberg will eventually be confirmed with but a very trivial alteration in terms.

This principle by modern chemiſts has been denominated oxygene, and is now ſuppoſed by ſome ingenious phyſiologiſts to be the principal agent by which the vital organs are excited to the performance of their ſeveral functions, and without which theſe muſt not only ceaſe, but even ſuffer very material alterations in their mechanical ſtructure. Sed " nullius exitium patitur natura " videri;" hence ſhe hath furniſhed us with ſuch principles as are beſt ſuited for the purpoſes of life and organization; and hath ſo varied the proportions of each in our atmoſphere, as to adapt it

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in a very particular manner to all the ſeveral varieties of conſtitution and diſeaſe; and it is by accepting the important hint ſhe hath given us, that we have ſo lately added to our ſtock of chemical and phyſiological knowledge, and by a proſecution of which we may one day hope to reduce the empiriciſm of medicine, and eſtabliſhed a more beneficial practice, on the more enlightened principles of pneumatic chemiſtry. Efforts have been made, and thoſe not puerile ones, by Beddoes, Girtanner, Goodwyn*, and others, in order to aſcertain and eſtabliſh the influence of oxygene, in the animal œconomy. From them we learn that the laws of irritability, and almoſt every phenoma attendant on animal life, in a great meaſure depends on the preſence of this principle. Dr. Goodwyn's experiments are ſo ſimple, and at

* Vide Goodwyn's Connection of Life with Reſpiration, a work, which though ſmall, is nevertheleſs pregnant with many important obſervations drawn from experiments equally diſtinguiſhed for their aptneſs of inſtitution, and the accuracy with which they were made.

the ſame time ſo fully adequate to explain its influence on muſcular motion, that a reference to his tract, would ſuperſede the neceſſity of quoting them here, but as his obſervations may not have been ſeen by ſome of my readers, I am the more willing to enhance the value of this work with an abſtract of his remarks on this ſubject. Speaking of ſome experiments, by artificial inflation, for aſcertaining the connection between reſpiration and the colour of the blood, and between the blood and contractions of the heart, he ſays "In "all the examples, I obſerved that when the blood "which paſſed into the left auricle was florid, the "auricle and ventricle contracted ſtrongly, and "the circulation went on *as in health*; but when "the blood began to put on a ſhade of *brown*, the "contractions were diminiſhed; and when it was "*black* the contractions ceaſed, although the auri-"cle was diſtended with blood; and as the con-"tractions ceaſed the functions of the body were "ſuſpended; but as ſoon as the florid colour was "reſtored, the auricle and ventricle reſumed their

"con-

" contractions, and they gradually recovered their
" natural ſtate; and all the other functions re-
" turned.

" In theſe examples the contraction of the left
" auricle and ventricle are immediately affected by
" the *quality* of the blood paſſing into them; for
" when they ceaſe, the auricle is filled with black
" blood; but notwithſtanding theſe facts, to ſuch
" as have particular opinions about the manner in
" which the blood acts upon the heart, it may not
" appear clear that theſe alterations in the con-
" tractions aroſe from the quality of the blood
" *alone*. This difficulty, however may be removed
" by attending to ſimilar experiments in the am-
" phibious animals, where the heart has only one
" auricle and ventricle, where the pulmonary ar-
" tery is a ſmall branch from the aorta, and the
" pulmonary vein proportionably ſmall empties
" itſelf into the ſinus venoſus and auricle, along
" with the vena cava aſcendens, which carries the
" principal part of the blood. Here the quantity

" of blood brought by the vena cava would be " ſufficient to keep up the action of the heart, in- " dependent of the pulmonary circulation, if quan- " tity alone were required ; and the coats of the " ſinus venoſus and auricle, as well as thoſe of " the blood-veſſels, are almoſt tranſparent : the " lungs alſo contain a quantity of air ſufficient " to furniſh the neceſſary chymical changes to " the pulmonary blood for a *conſiderable time* with- " out any communication with the atmoſphere ; " ſo that the alterations which take place in the " colour of the blood, and in the motions of the " heart, in conſequence of obſtructed reſpiration, " are more gradual and diſtinct, than in the ani- " mals with double hearts, in which all the blood " paſſes through the lungs.

" I confined a large living toad on a plate of " metal, with his belly upwards ; then I removed " a part of the ſternum, and his heart and lungs " were expoſed to view. The lungs were then " filled with air ; the blood in the pulmonary

" veins

" veins was florid, and the heart contracted *forty-*
"*four* times in a minute. In this ſtate he was
" immerſed in a ſmall quantity of tranſparent wa-
" ter, where the alterations in the colour of the
" blood and in the contractions of the heart, could
" be accurately diſtinguiſhed. When he had re-
" mained in the water fifteen minutes, the blood in
" the lungs began to put on a dark colour, and
" the contractions of the heart were diminiſhed to
" *thirty*. In fifteen minutes more the dark colour
" of the blood was increaſed, and the contrac-
" tions of the heart were *eighteen*. The animal
" now made ſeveral ſtruggles to relieve itſelf, and
" threw ſome air out of its lungs ; but the pulmo-
" nary blood becoming ſtill more dark coloured,
" the contractions of the heart were diminiſhed
" ſtill farther, and in *forty minutes* more they
" ceaſed ; although the ſinus venoſus and auricle,
" and the trunk of the vena cava, were filled with
" black blood. The animal was now removed
" from the water, without any ſigns of life ; but
" before the expiration of *two minutes* he opened

his

" his mouth and took a large quantity of freſh
" air into his lungs. Soon after he emptied them
" almoſt entirely ; and this was repeated ſeveral
" times. During the proceſs, the blood in the
" pulmonary veins began to be florid, and the
" heart to renew its contractions ; and in *fifteen*
" *minutes* from the firſt inflation the contractions
" of the heart were *thirty-five*, all the functions
" were recovered and he walked about without any
" expreſſions of uneaſineſs.

" This experiment was repeated ſeveral times
" on the ſame toad ; and ſometimes when he did
" not fill his lungs, after being removed from the
" water, we injected ſome air into them with a
" blow-pipe, and preſſed it out afterwards, in imi-
" tation of the example he had given us ; and by
" theſe means we renewed the contraction of the
" heart ſeveral times. But at length he was re-
" moved from the water, and ſuffered to remain
" an hour before freſh air was injected into his
" lungs. Soon after it was injected the blood in

" the

" the pulmonary veins become florid; but the " heart did not again renew its contractions."

Theſe experiments he repeated on the lizard; and in every caſe the contractions of the heart were leſs frequent, in proportion as the pulmonary blood became darker, and vice verſa. And though in every example the quantity of blood which flowed to the heart was ſufficient to keep up its contractions, yet ſtill were they gradually diminiſhed in proportion to the dark colour of the blood; and ſo as that, when it was *black*, they ceaſed altogether. Hence he very naturally infered that from the *quality* of the blood *alone* could ariſe theſe alterations in the motion of the heart. And that the *chymical quality which the blood acquires in paſſing through the lungs, is neceſſary to keep up the action of the heart, and conſequently the health of the body.*

From hence he drew thoſe remarks on the nature and effects of *ſubmerſion* and *ſtrangulation*, and on the cure of theſe diſeaſes; as muſt be equally

qually important to the man of humanity as to the medical practitioner, and the intrinsic value of which cannot be too highly esteemed by every useful member of the community.

It were much to be wished that the investigation of these, and other similar phenomena, were more universally imparted to mankind than can possibly be expected through the medium of *medical publications*, which are, in general, supposed to be full of theoretical disquisitions, too abstruse for the understanding of any man who is not versed in the science of medicine.—Perhaps, if delivered to the world as matter of curiosity, it might excite more effectually the active spirit of enquiry, and rouse the benevolent exertions of philanthropy, to prevent the dangerous *monopoly* of science.

The opinions of Doctors Beddoes and Girtanner seem evidently to confirm those of Dr. Goodwyn; but they go still further and suppose the solid fibre acquires its faculty of irritability from the oxy-

gene

gene which the lungs and circulation of the fluids are continually ſupplying; and that unleſs the action of ſtimuli applied to the irritable fibre, be ſufficiently ſtrong to carry off any ſurplus of this irritable principle, the fibre will become ſurcharged therewith, and that equilibrium neceſſary to its moſt perfect ſtate will be deſtroyed: while, on the other hand, a total or irreparable exhauſtion of this principle from the fibre deſtroys its faculty of irritability; as in the caſe of gangrene. The fibre ſuffers a change of colour, becoming dark and afterwards *black*; ſubject to the laws of inorganized matter, beginning to decompoſe and putrefy.

A very powerful ſtimulus will, in a very ſhort time, reduce the fibre to this ſtate. Such, for inſtance, is the ſtate of the fibre in animals killed by very ſtrong poiſons, by the bite of the rattle-ſnake; in animals deſtroyed by a knife dipped in the juice of the aconite, or by poiſoned arrows. The ſame effects will be produced by weak ſti-

muli

muli (though in a more gradual manner) when conſtantly acting upon one part of the ſyſtem, ſuch as *ſlow poiſons*, the abuſe of ſpiritous liquors, &c. which in the end exhauſts the whole ſyſtem and produces death. Hence we are led to ſay with Cicero "Arteria animam accipit è pulmonibus."

By putrefaction, expoſure to air, or a long continued heat equal to 96° of Fahrenheit's ſcale, the whole maſs of blood, but more eſpecially the ſerum, is converted into a very fætid liquor, firſt the ſerum, and afterwards, but more ſlowly, the red cruor, till at length both it and the ſerum leaving very few fæces hehind, is diſſipated in the form of a volatile fætid exhalation. The blood becomes fætid when a little diſſolved by beginning putrefaction, at the ſame time aſſuming an alkaline quality, which is again deſtroyed in the advanced ſtage of putreſcency.

Putrid

Putrid blood cannot be inſpiſſiated by any means with which we are acquainted, and its reſolution is extremely difficult, after having been coagulated by rectified ſpirits. By expoſure to a regular and continued, gentle heat, it undergoes the putrid fermentation. When heated more ſtrongly it coagulates, gradually dries and, as De Haen has diſcovered, loſes $\frac{7}{8}$ of its weight and effervesces with acids; and by a well managed fire, it may be hardened into a corneous, bony, or even ſtony ſubſtance.

The colour of the blood becomes brighter and deeper, by the addition of neutral or fixed alkaline ſalts, both of which produce almoſt ſimilar effects without either thickening or rendering the blood more fluid. The volatile alkalies give it a brown tinge, and coagulate it, which laſt phenomena takes place alſo by the admixture of rectified ſpirits, diſtilled oils, or vinegar*. As far as my own

* Anatomiſts have ſaid that the deep colour of the blood of the chick in egg, aroſe ſolely from the deep ſeat of the vein; but from many experiments I am warranted in

 experiments

experiments and the aſſertions of others lead me to infer it does not effervesce with any ſalt.

A weak acid ſcarcely alters it, but the ſtronger ones coagulate it immediately, producing a change of colour. By filtrating, and evaporating the filtrated liquor to dryneſs, over a gentle fire and afterwards lixiviating the reſidual matter we may obtain ſuch neutral ſalts, as each acid forms with ſalt of Soda*.

The blood contains in its ſubſtance a conſiderable quantity of marine ſalt, which is evident to the taſte, and ſometimes even viſible by the microſcope, theſe ſaline particles are ſaid to be more abundant in its moſt ſerous parts. May not the preſence of theſe ſaline particles in the gaſtric juice, contribute much to the diſſolution of our aliments, and be otherwiſe ſerviceable in ſtimulating the veſſels? That it contains earth is eaſily

aſſerting, that the chick has no ſooner breathed, than its blood becomes more florid.

* Vide Fourcroy's Elem. Chem. &c.

demonſtrated

demonſtrated from chemical analyſis, and from the phenomena of nutrition; it is principally found in the moſt fluid, and more eſpecially in the oleaginous parts of the blood, it conſtitutes about a 150th part of the whole maſs, containing ſome ferruginous particles attracted by the magnet; its quantity is continually increaſing, in proportion as the nutritious parts of our food abounds with it, whereby the brittleneſs of the bones, and hardneſs of every other part is increaſed, it being every where depoſited in the cellular texture and more eſpecially in the coats of the arteries, producing cruſts, at firſt callous, but which afterwards, aſſume a bony or even ſtony nature; as is frequently ſeen in the beginning of the aorta in perſons far advanced in years, and the valves of this artery have been found covered with chalky concretions, which by preventing them from performing their office, kept the left ventricle of the heart conſtantly overcharged with blood, diſtending it to twice its natural ſize, inducing a marked debility in the animal functions, and there-

by

by dropſy. I have likewiſe found theſe depoſitions of calcareous earth and oſſification of the coats of this artery in caſes of aneuriſm.

It is the depoſition and accumulation of this earth, between the primœval fibres of a bone, which conſtitute and finiſh the proceſs of oſſification; but which being reabſorbed and conveyed into the circulating maſs, as is ſometimes the caſe, may give riſe to the above mentioned and perhaps many other diſeaſes, as may be inferred from a conſideration of the nature of the gouty earth, biliary concretions, calculi, &c. The abundance of this is perhaps the worſt quality which our humours can poſſeſs. And this encreaſed hardneſs and rigidity of the whole animal body, diminiſhing the muſcular powers, and debilitating the ſenſes, conſtitute *old age*. An evil, alas! which ſooner or later attends every mortal, who is not cut off by other premature means. Its acceſſion is earlier in thoſe who have been ſubjected to hard labour, or violent exerciſe; or in thoſe who have given

given themſelves up to pleaſure in every criminal exceſs, living upon unwholeſome diet, and uſing indiſcriminately and freely the moſt inebriating liquors; than in thoſe who on the contrary, have ever ſtrictly adhered to a moderate or abſtemious courſe of life, uſing temperance in every thing, and cautiouſly avoiding every baneful influence: or in ſuch as have removed from a cold to a warm climate.

By ſome late experiments a conſiderable quantity of metallic calx has been found in the blood, when calcined, and which is eaſily reducible by any matter which has a ſtronger affinity with oxygene than the metal with which it was combined.

That air is contained in the blood in an unelaſtic ſtate, and that too in a very conſiderable quantity, is proved by putrefaction and diſtillation, or by its expanſion in an exhauſted receiver; though as I have remarked we are not to ſuppoſe

poſe that the red globules are bubbles full of air, as their being ſpecifically heavier than the ſerum is ſufficient to refute any argument, which may be advanced in ſupport of ſuch an opinion.

Chemiſtry has in various ways elucidated the nature of the blood. When firſt drawn, and diſtilled with a ſlow heat, before the putrefactive proceſs commences, it yields an aqueous fluid to the quantity of five parts in ſix of the whole maſs; poſſeſſing very little taſte or ſmell, till towards the finiſhing of the operation, when it becomes more or leſs charged with a very fœtid oil. This aqueous fluid very readily putrifies.

The reſidual matter when expoſed to a ſtronger heat yields different alkaline liquors, the firſt of which being fætid, acrid, and inclining to a red colour, has been uſually called the ſpirit of the blood, conſiſting of a volatile ſalt with a ſmall proportion of oil, held in ſolution by water, to the amount of about 1-20th part of the original maſs.

An

An acrimonious liquor very ſimilar to this may be extracted from the fat, as alſo from putrid fleſh and blood—It contains a ſmall proportion of marine ſalt.

Somewhat ſooner, and along with the oil, there ariſes a dry volatile ſalt, adhering to the neck and ſides of the glaſs in branchy flakes, but in a very ſmall quantity, amounting only to about an *eighth* part of the whole maſs.

The oil which comes over next is at firſt yellow, afterwards blackiſh, and at laſt bears a great reſemblance to pitch, being exceedingly acrid and inflammable; and in the proportion of about one *fiftieth* part of the whole maſs. The reſiduum left in the bottom of the retort is a porous inflammable coal or cinder, which burns and leaves aſhes behind; and from which by ablution with water, a mixed ſalt may be obtained, compoſed partly of marine ſalt, and partly of fixed alkalies, with a ſmall quantity of fixed earth. This fixed

ſalt

ſalt does not occupy more than about one *five hundredth* part of the original maſs, and of which only *one fourth* is alkaline.

When calcined by an intenſe heat, it affords a ſmall quantity of an acid ſpirit, which is ſuppoſed to be owing partly to the marine ſalt in the blood, and partly to thoſe parts of our vegetable aliments not yet animalized by digeſtion* ; and from this laſt we may underſtand how an acid may be procured from the blood of graminivorous animals as well as from that of man.

By diſtillation on a water bath, a phlegm of a faint ſmell is afforded, which is neither acid nor

* The digeſtive and aſſimilating powers of the animal œconomy are fitted to prepare from the aliments taken in, a fluid ſuited to the purpoſes of that œconomy, particularly for the nutrition of the more ſolid parts ; and ſuch fluid, whilſt in a condition fit for its purpoſe, we preſume to be bland, mild, and nowiſe noxious or hurtful. But if there exiſt any morbid dificiency in the aſſimilating powers of digeſtion, theſe qualities muſt be ſenſibly altered.

alkaline,

alkaline, but which by virtue of an animal ſubſtance it holds in ſolution, readily putrifies.—Dried blood when expoſed to the air ſlightly attracts humidity, and in the courſe of a few months, a ſaline efflorescence is formed upon its ſurface, which Rouelle diſcovered to be ſalt of ſoda. When diſtilled with a naked fire it affords a phlegm in the ſtate of ſal ammoniac, ſuperſaturated with fixed alkali. Weiuſſens firſt diſcovered this empyreumatic acid, the nature of which has excited ſo many diſputes among phyſiologiſts, and which has not hitherto been properly examined. A light oil is afterwards forced over, ſucceeded by an oil more ponderous and coloured, and laſtly the thick oil with concrete volatile alkali; the reſiduum in the form of a ſpongy coal remains in the retort, very difficult of incineration, containing ſea-ſalt, cretaceous ſoda, iron, and an earthy ſubſtance which is found to be calcareous phoſphate. Rouelle has beſtowed much time and pains in examining the blood of different animals, and more eſpecially quadrupeds, as the ox, horſe, calf,

ſheep, hog, aſs, and goat; he obtained the ſame products from all of them as from the human blood, only in very different proportions.

By experiments made on the blood in its original ſtate, we are not enabled to demonſtrate the nature of the component parts of this fluid; but its ſpontaneous decompoſition and ſeparation into two parts, the craſſamentum and ſerum, affords us different methods of accompliſhing this, by a ſeparate examination of each ſubſtance. The chemical analyſis of the blood was confined to very narrow limits till within theſe few years, when the labours of Minghini, Rouelle the younger, Bucquet and others, threw a great light upon the ſubject, and by their experiments and obſervations opened a vaſt field for the inquiſitive chemiſt, anatomiſt, or phyſiologiſt to indulge the luxuriancy of his imagination, and plainly evince that by a ſteady purſuit of thoſe paths which they have pointed out to us we may hope to arrive at the greateſt perfection in the analyſis of animal

matters,

matters, and from the obſervations and reſearches of ſuch learned men, joined to thoſe facts which we have been able to collect, we ſhall proceed to the conſideration of the properties which characterize the different ſubſtances of which this heterogenous aggregate is compoſed; and firſt of the ſerum.

The *ſerum* is a peculiar fluid, whoſe chemical and phyſical properties, it is of great importance to underſtand, and as by a careful examination of its conſtituent parts, many very uſeful practical hints may be deduced, we ſhall conſider it at ſome length.

It is not pure water as ſome have ſuppoſed, but a tranſparent aqueous fluid, of a yellowiſh green colour, denominated by ſome authors the *albuminous* fluid. It is not as it would ſeem homogenous, and is ſpecifically heavier than water by one *thirty-eighth* part, and the craſſamentum is heavier than this fluid, by nearly *one twelfth*. It is found

floating

floating on the ſurface of the craſſamentum, which it every way ſurrounds, the red cruor being as it were completely immerſed in it. It is of a dull brackiſh taſte, and ſomewhat unctious and adheſive. It coagulates and hardens by a heat much leſs than 212° degrees of Fahrenheit's thermometer, and will take a concrete form much harder than the craſſamentum by the commixture of acids, or rectified ſpirits, as alſo by a concuſſive motion, forming firſt an indiſſoluble glue, afterwards a fleſhy membranous ſubſtance, and at length ſhrinks up to a corneous ſubſtance, or friable gum; on preſſing this coagulum, a ſmall quantity of a ſerous fluid diſtils from it, which has been called the ſeroſity of the blood, and in which its neutral ſalts, or whatever occaſions its ſaline taſte, are ſaid to reſide.

When once coagulated it is incapable of becoming fluid again. When diſtilled on the water-bath it gives over a mild inſipid phlegm, neither acid nor alkaline, but which advances rapidly to putrefaction;

putrefaction; the reſiduum is dry, hard and tranſparent like horn, no longer ſoluble in water, but which, by a ſtrong heat, gives over an alkaline phlegm, a conſiderable quantity of concrete volatile alkali, and an intenſely fœtid oil. All its products are of a very diſagreeable fœtid ſmell.

The reſiduum of this laſt proceſs is a coal very difficult to incinerate, and which when diſtilled by a naked fire almoſt fills the retort. It is ſo difficult to incinerate, that it cannot be reduced to aſhes, unleſs it is kept in a red heat for ſeveral hours, with a large ſurface expoſed to the air. Theſe aſhes are of a dark grey colour, containing marine ſalt, cretaceous ſoda, and ſome calcareous phoſphate.

When expoſed in an open veſſel to a warm temperature for a certain length of time, it ſoon putrifies, affording concrete volatile alkali of an abominable ſmell, in conſiderable quantities. Its putrefaction proceeds ſo rapidly, as not to afford

Bucquet

Bucquet an opportunity of deciding whether it paſſes to an acid ſtate, before it becomes alkaline. It readily unites with water in any proportion, loſing its conſiſtence, taſte, and greeniſh colour, but not perfectly unleſs their union is promoted by agitation, as their different denſities in ſome meaſure keeps them aſunder. When poured into boiling water it in general coagulates inſtantly. When diſſolved in water it forms a white opake ſomewhat milky fluid, which Bucquet ſays poſſeſſes all the characteriſtic properties of milk, as in affording cream, coagulating by heat, acids, &c. By the addition of alkalies it is rendered more fluid, as it were by a kind of ſolution.

Acids, as I have juſt obſerved have a directly oppoſite effect, and form therewith a concrete ſtubſtance, which by filtration and evaporation affords ſuch neutral ſalts, as the acid made uſe of forms with ſalt of ſoda, a fact which, beyond a doubt, proves the exiſtence of ſalt of ſoda in the blood

blood, diſengaged and poſſeſſed of all its properties.

The ſubſtance which this fluid forms by the addition of acids is very readily diſſoluble in volatile alkali, which is the proper ſolvent of the albuminous part; but it is far from being completely ſoluble in pure water. When united to volatile alkali it may be decompoſed and precipitated by the admixture of acids. It affords by diſtillation with a naked fire pretty near the ſame products as are obtained from dried ſerum, and its reſiduum contains cretaceous ſoda in no inconſiderable quantity, from which Bucquet concludes, that there is a portion of ſalt of ſoda ſo intimately combined in the ſerum, as not to be completely ſaturated by the coagulating acid.

The ſerum by the action of the nitrous acid, when expoſed to a gentle heat, affords mephitis and by the application of a greater heat to the mixture nitrous gas is ſet at liberty; the reſidue affords

fords acid of ſugar and a very ſmall quantity of that peculiar acid, which M. de Morveau calls the *maluſian acid.*

The decompoſition of metallic ſalt takes place very readily by the addition of ſerum, which produces no ſuch effect on the calcareous and argillaceous neutral ſalts. It is coagulable by alkali, as I have before remarked, and the coagulum produced by this union differs very conſiderably from that formed by the action of acids, which laſt is very difficultly ſoluble in water, but which, as Bucquet has diſcovered, is not the caſe with ſuch as is formed by rectified ſpirits. Theſe are not the only phenomena in which theſe coagula differ. The ſerum contains beſides the coagulable albumen, a conſiderable proportion of ſimple water, and ſome mucus, not ſo eaſily drawn into threads as the craſſamentum, and not influenced by heat or acids, in a manner ſimilar to this albumen.

A ſecond kind of lymph has been diſcovered by Hewſon, which was alſo obſerved by Krauſius. The pleuritic cruſts, polypi, and artificial membranes are, according to different anatomiſts and phyſiologiſts, formed from this part of the blood.

From the foregoing experiments therefore, we conclude, that the ſerum is an animal mucilage, compoſed of water, acidifiable oily baſes, marine ſalt, cretaceous ſoda, and calcareous phoſphate. This laſt was the ſubſtance which Fourcroy ſuppoſed to produce the roſe-coloured precipitate, which he obtained by the union of ſerum and a ſolution of mercury in the nitrous acid. This appearance he obſerved in many other animal fluids as well as the ſerum. After the addition of mercurial nitre, and even of nitrous acid alone, producing a roſe or light fleſh colour, though before ſuch addition the liquid was ſcarcely coloured. This mucilage becoming concrete by the action of fire and acids, is a ſingular property, and which before any other merits the attention of phyſicians.

Mr. Scheele thinks the combination of heat produces this phenomena.

We have ſhewn then, that from the ſerum by the agency of fire, pretty near the ſame principles may be extracted though in different proportions, as from the craſſamentum when obtained by ſimilar proceſſes; yielding however much more water but no iron at all. It would ſeem that thoſe two ſecretions, ſaliva and mucus, have a great affinity to ſerum, as ſimilar principles only with a leſs proportion of oil and ſalt, and more abundant aqueous parts, may be obtained from both theſe humours.

The coagulable parts of the ſerum ſeem more eſpecially deſigned for nutrition, and the thinner juices ſecreted from it, ſerve various purpoſes highly uſeful to the animal œconomy; ſuch as the diluting and aſſiſting the diſſolution of our aliment, preſerving the natural moiſture of different parts, preventing the ſolids from becoming rigid

rigid and inflexible, or from ſuffering by abraſion in the different motions of the body, which muſt have inevitably been the conſequence, had not our all-wiſe and even provident Creator prevented their attrition by a ſecretion of lubricating juices proportioned to their different quantities of action.

Hence we ſee various diſorders take their riſe from either a ſcarcely or abundance of theſe ſeveral fluids which, though, apparently, perhaps trifling in themſelves, yet when conſidered in their official capacity as a neceſſary inſtrument of human exiſtence, they become of infinite importance; no leſs ſo perhaps (comparatively ſpeaking) than the more complicated organs ſo eſſentially neceſſary to life; and indeed we ſee daily that any morbid deviations in the diſtribution of theſe fluids produce *ultimately* ſimilar effects, as acrue from any preternatural influence exerted on the apparently more important organs, for the *ultimate* conſequences may be equally fatal, however widely the rapi-

dity

dity of their progreſs, and the painful influence of their effects may differ: for no one would pronounce an animal healthy, when deprived, and in the actual want of any one natural quality of which it ought to be poſſeſſed; ſince it muſt be obvious, that every the moſt minute part of an animal, has a *proportionately* equal influence on the œconomy and welfare of the whole; however trivial it may appear when conſidered in an abſtract point of view.

The ſerum, according to Sir John Pringle, Mr. Gaber, and others, is that ſubſtance which alone is capable of producing *genuine pus*; and not as Boerhaave, Platner, and many others are of opinion; that it is formed by a diſſolution of the blood-veſſels, nerves, muſcles and other ſolids in the fluids of thoſe parts in which inflammatory tumours occur: for it is evident from the experiments of Sir John Pringle* as well as thoſe of Mr.

* Vide Apendix to his Treatiſe on Diſeaſes of the Army.

Gaber

Gaber related by himſelf in the ſecond volume of the Acta Taurinenſia, that, far from affording good pus, the mixture of any of theſe ſubſtances, induces a degeneracy in the matter of ulcers. An opinion which ſeems highly probable, has been advanced with regard to the formation of pus from ſerum, as by a degree of fermentation raiſed upon the ſerous parts of the blood after its ſecretion into the cavities of ulcers and abſceſſes, in conſequence either of the natural heat of the parts or of heat artificially applied: and ſome experiments of Sir John Pringle ſeem greatly to elucidate this opinion, for by expoſing pure ſerum in a furnace regulated to the human heat, he found, that in a few days, after becoming turbid, it depoſited a white purulent ſediment, but the craſſamentum, under exactly ſimilar circumſtances, from a deep crimſon changed to a dark livid colour, which, when mixed with water, gave it a tawny hue, and which was the caſe with ſerum when a few red globules were added to it, though digeſted for the ſame ſpace of time, and in the ſame degree

of

of heat. Mr Gaber's experiments all tend to elucidate and corroborate the ſame opinion. Is it not more eſpecially the *coagulable lymph* or *albuminous* parts of the ſerum from whence good pus is generated*? All the ſerum in the body has been ſometimes found white as milk, owing to a ſuperabundance of chyle; this ſubſtance on being mixed with the blood, does not immediately change its nature, as is evident from milk being afterwards made from it; but after having circulated through the body and been mixed with a variety of animal juices, fomented with heat, it undergoes a material alteration, part being depoſited in the cellular texture under the form of an unctious ſubſtance called fat, and which is ſometimes reabſorbed; a part is deſtined for the generation of red-globules, another portion changes into ſerum, and its more fluid parts paſs off, ſome by urine and ſome by perſpiration, a ſmall

* Vide Bell on Ulcers, p. 60.

quantity

quantity being retained in the habit to dilute the blood.

We are now come to treat of that part of the blood which, after having ſtood for a certain length of time, ſpontaneouſly ſeparates from the ſerum, in which it ſinks, and takes the form of a tremulous coagulated maſs, called the *craſſamentum*, and which is variouſly modified with regard to its firmneſs and denſity, according to the different modes of its extraction, and peculiarities of the parts from whence it is taken.

It is evidently compoſed of two parts very different from each other, and which prevailing or diminiſhing, either in their ſeparate or joint capacity are capable of affecting the moſt important revolutions in the animal œconomy.

Many have been the attempts made, in order to eſtimate the proportionate quantity of the craſſamentum to that of the ſerum in human blood when

when drawn from its containing veſſels, yet are we not able from any experiments hitherto made, to eſtabliſh a *certain* concluſion.

Their *apparent* proportions are very fallacious ; being conſiderably varied by thoſe circumſtances which influence the time neceſſary to effect its concretion, and from the time of its coagulation to that of its proportions being examined.

We have had numerous opportunities of obſerving the influence and effects of collateral circumſtances in blood letting, and could never accurately determine the proportionate quantities of the red cruor and ſerum.

We have frequently been able to join the learned Hallei in affirming that, " In maſſa ſanguinea " media pars, et ultra, cruoris eſt. In robore " valido ſerum minuitur ad tertiam partem, in " febre ad quartam et quintam reducitur, in mor- " bis a debilitate increſcit* ;" and as often have

* Vide Primæ Lineæ, parag. 137.

we

we found the ſerum abundant, and the craſſamentum reduced to a third or even fourth part.—But even ſuppoſing we were in poſſeſſion of the moſt exact eſtimate of the ſerum with reſpect to the red cruor, yet muſt it ſtill remain undetermined what proportion, the red globules and gluten (of which the red cruor is compoſed) bear to one another, and conſequently, it is not fully aſcertained what is the uſual proportion of red globules in the blood of perſons in a ſtate of health.

It ſeems highly probable that in a healthful ſtate of the body, not only the red globules, but alſo the gluten may be increaſed or diminiſhed, in proportion to the *quantity*, or in ſome meaſure according to the *quality*, of the aliments taken in during a given time: but this will not fully enable us to determine what is the proportion in the healthful bodies of different perſons, and conſequently what ſhare they may afford in giving a difference of temperament.

It may be presumed however, that with respect to the serosity, the proportion of red globules and of gluten taken together, will be greater or less according to the digestive and assimilating powers in each person; and that these again will be according to the general strength or weakness of the system*.

We have already said that the red cruor is composed of two separate and distinct parts, but first let us examine it as an aggregate body, and which is specifically heavier than the serum, by about *one twelfth* part.

By the heat of a water bath it affords an insipid water, and then becomes dry and brittle. It gives over by distillation an alkaline phlegm, a thick, fœtid, empyreumatic oil, and volatile alkali in a considerable proportion.

* Vide Cullen's Materia Medica. Chap. I, Sect. I. Page 69.

The

The reſidual coal is porous, and of a brilliant and metallic aſpect, very difficult of incineration, affording vitriols of iron and of ſoda, when united with vitriolic acid in a certain degree of heat, leaving a mixture of carbonaceous matter and calcareous phoſphate.

It readily putrifies when expoſed to a warm air, and is ſeparable into two diſtinct ſubſtances, by maceration in water, which becomes tinged more or leſs with a red colour, by one of the ſubſtances which it holds in ſolution; and this mixture when heated with different menſtrua, exhibits all the characteriſtic properties of *ferum*, differing principally in the greater quantity of iron it contains, which is very conſiderable, and may be obtained by incineration of the reſidual coal, and afterwards viating, in order to ſeparate the ſaline particles.

This metal it naturally contains in the ſtate of calx, and which is eaſily reducible by the addition of any oleaginous, or carbonaceous matter, with the

the aſſiſtance of heat, as we have already had occaſion to remark in a former part of this work.

The reſidue after lixiviation is ſaffron of Mars, of a beautiful colour, and moſtly attracted by the magnet. It is to this metal that many have attributed the colour of the blood.

The red globules we have already deſcribed, and ſhall therefore proceed to an examination of the coagulable lymph, which is the third and laſt component part of the blood.

It is this ſubſtance, which being diffuſed through the other part of the blood, takes a concrete form when expoſed to the influence of air; or when diſcharged from its containing veſſels into any part of the body; and which being thrown out upon ſurfaces may produce adheſions of parts, which in their natural ſtate were not united, but in ſome caſes admitted of free motion, many inſtances of which we have in the lungs adhering

hering to the ribs, pericardium to the heart, &c. and in anchyloſis where it is poured round the joints in a fluid form, manifeſtly filling up the chinks of bones, and intervals of ſutures; and which being thrown out upon wounds is the moſt natural balſam both for the defence and union of the divided parts*.

The coagulation formed by this ſtubſtance becoming at length organized, veſſels may be clearly ſeen ramifying through it; as in moles or falſe conceptions which in general are nothing more than coagulated blood, which had been gradually collected at different times from the veſſels of the uterus, and are diſcharged at a particular time, and have frequently been found wholly vaſcular. Theſe, however, have been known to take their riſe from a retention of the embryon placenta, which ſometimes remains after the expulſion of the gelatinous fætus in the early months, the

* Vide note to page 44 and 45.

bulk

bulk of which is encreaſed by additional coagula, and its conſiſtence may probably be rendered more denſe by abſorption of the more fluid parts; when excluded in this ſtate it has been called a *falſe conception*. But if it ſhould remain longer, and acquire the conſiſtence of a ſchirrus, having loſt all traces of its ever having been an organic body, it is called a mola. This mola or mole is generally expelled in the courſe of the ſecond, third, or fourth month, if it ſhould continue longer, it may prove extremely troubleſome by the flooding it occaſions; and, in weakly delicate habits, may induce death*.

There are however inſtances in which theſe mola have remained in the uterus for a very conſiderable time, without producing any material injury, and even the entire fætus has been known to have been retained in the uterus or abdomen for years;

* Vide La Motte, Mauriceau, Smellie, Hamilton and other practical authors on Midwifery.

ſometimes during a long courſe of life. A very remarkable inſtance of which I remember to have occured at the Village of Ilkeſton, near Nottingham: the woman ſometime after conception received a kick on the gravid uterus, ſoon after which, labour pains came on, but again went off, without effecting the delivery of the child,—ſhe lived upwards of forty years after this accident without experiencing much inconvenience from the preſence of the child, which was evidently felt during the whole of that long term. On inſpection after death, the uterus was found lacerrated towards the right ſide, and the whole of the fætus (except the head) was found in the cavity of the abdomen where it had formed numerous adheſions with the contained viſcera; having become organized by the ramification of veſſels very evident and numerous throughout the whole. At the time of this inſpection it exhibited ſigns of beginning putrefaction.

The coagulable lymph is in ſhort the general bond

bond of union between parts that were ſeparated. By it are broken bones, and wounded parts united, and afterwards become organized, as is proved by the phenomena of the growing callous, exuding in minute drops from the inmoſt ſubſtance of the bone and not from the perioſteum as ſome have imagined; and which in proceſs of time gradually indurates.

This *gluten* may be extracted from bones by a chemical analyſis; it contains groſs earthly particles, and may be diſtinguiſhed by the juice of madder, the colouring matter of which ſtrongly adheres to it.

The *lymph* not only changes from the natural ſtate to the more watery, but ſometimes varies from the natural to the more viſcid and coagulable, producing thoſe inflammatory cruſts which are found in ſome diſeaſes covering the different parts of the body.

Thus

Thus we have many inſtances, where the outſide of the heart, and inſide of the pericardium have been found covered with a cruſt equally tough as the ſize uſually found in pleuritic blood, the ſurface underneath having marks of inflammation but no ulcer.

Probably therefore this change may be produced by inflammation, or by exciting the exhalant arteries to ſecrete a lymph, with ſuch an encreaſed diſpoſition to coagulate ; and this ſuppoſition is rendered probable, from a cruſt having ſometimes been found on the inner ſurface of the heart, ſimilar to that we ſo often obſerve formed on its outer ſurface ; a peculiar inſtance of which was obſerved by Sir John Pringle in a perſon who died apoplectic, having previouſly laboured for ſome time under a palpitation of the heart; on inſpection of the heart, there was found evident marks of inflammation on its ſurface, and an abſceſs on the right ventricle, which muſt inevitably have burſt, had not an opening from it been co-

vered and ſhut up by a ſmall cruſt or polypus, which occupied a ſpace in the ventricle.

Now as the flow of blood through the heart is ſtrong and conſtant, had not the lymph forming that cruſt, coagulated inſtantly on being ſecreted it muſt have been waſhed off by the blood, and as the coagulable lymph is not naturally diſpoſed to ſo inſtantaneous a coagulation, it is more than probable that a morbid affection of the veſſels endued them with the power of effecting this change ; as by an increaſed heat and action either of the whole ſyſtem, or of particular parts.

The fluids which moiſten the different cavities of the thorax, abdomen, &c. are very probably compoſed of a mixture of this lymph and water, and that mixture varies from the dropſical, where the aqueous parts are conſiderably more abundant, up to the rheumatic or inflammatory habit where the lymph abounds and the watery parts are proportionately diminiſhed ; and numerous obſervations

vations confirm, that in ſome caſes the lymph in paſſing through inflamed veſſels, is converted into the ſtate of a purulent matter, ſimilar to that which is found in well conditioned ulcers, &c.

Hence it is obvious, many and various diſorders may derive their origin, from particular modifications of the quantities and conſiſtence of this fluid. And hence a powerful argument in favour of the opinion, that pus is ſometimes ſecreted in its perfect ſtate from the maſs of blood: for if we allow that the exhalant veſſels ſecrete, at one time an aqueous fluid, at another gelatinous lymph, and at a third, when ſomewhat inflamed, that lymph ſo viſcid and ſo much altered in its properties as to coagulate inſtantly on being ſecreted, it is equally probable that they may ſometimes, when more inflamed, have the power of ſecreting that lymph in the form of pus. Mr. Hewſon in one inſtance found three pints of pure pus in the pericardium, without any ulcer of that membrane, or of the heart. And in another the

cavity

cavity of the pleura of the right ſide was ſo much diſtended with pus as to compreſs the lungs into a very ſmall compaſs, and which partook more of a whey-like ſmell than of a putrid fluid, but without any appearance of ulcer or eroſion, either on theſe organs or on the pleura, there being only a thin cruſt of coagulated lymph under the pus.

There are ſome ſurfaces of the blood which are defended from the influence of the external air by mucus, but we find under circumſtances of imflammation that coagulable lymph is thrown out upon them, and which by inſpiſſation forms a membranous appearance; an occurrence which often takes place in the courſe of the alimentary canal. Mr. Cline remarked a caſe of this kind in a boy who had ſuch a membrane throughout the whole length of the inteſtines.

Conſumptive perſons have been ſuppoſed to ſpit or cough up their lungs, when it was nothing elſe than the coagulable lymph, which had been adher-

adhering to the bronchiæ, and which muſt have greatly obſtructed reſpiration ; after theſe are diſcharged, the complaint vaniſhes, and the patient is eaſy until more is formed.

Another particular phenomenon which is exhibited by the coagulable lymph and which very much directs practitioners in judging of the preſence of inflammation, is ſuppoſed to ariſe from any inflammatory affection exiſting in any part of the body, as the lungs, or any of the viſcera, &c. and frequently found on the ſurface of coagulated blood, and which hath been denominated the *buff* or *ſize*. This appearance is produced by a portion of the gluten ſeparating from the craſſamentum and is much firmer in texture than this laſt, upon the ſurface of which it is found.

Sydenham obſerves " That if you agitate the " veſſel while the blood is coagulating, this ap- " pearance does not take place ;" he therefore concludes " that it depends more on accidental circumſtances

" cumſtances than on any morbid change, as the " manner in which the blood is drawn from the " body &c. He remarks, that if it be ſuffered to " trickle down the arm, no ſuch phenomenon ſu- " pervenes, but that if drawn in a full ſtream the " inflammatory cruſt ſeparates from the maſs;" however we do not always find this to be the caſe; we ought not therefore from the abſence of ſuch appearance, to conclude againſt the preſence of inflammation; ſince a variety of circumſtances in blood-letting may prevent this ſeparation of glu- ten from taking place in blood otherwiſe diſ- poſed to it*.

When the blood after cooling and concreting, ſhews a portion of the gluten ſeparated from the maſs, and laying on the ſurface of the craſſamen- tum; as ſuch ſeparation generally occurs in all caſes of more evident phlegmaſia; ſo in ambi- guous caſes, we from this appearance joined

* Vide Cullens firſt lines.

with

with other ſymptoms, infer the preſence of inflammation.

It would ſeem that the formation of this buff in ſome meaſure impeded the coagulation of the blood, for Mr. Cline remarked, that in a patient who laboured under an acute rheumatiſm, his blood did not coagulate in *twenty four hours*, nor then till he removed the inflammatory buff from the ſurface, and I have frequently obſerved that ſuch blood as afforded this ſize in the greateſt quantity, was proportionately longer in coagulating, and in two inſtances where the patients had been much exhauſted by previous blood-lettings, the blood afforded nothing elſe than a portion of this ſize ſwimming upon the ſurface of a large quantity of ſerum, of a dark tawny hue, which being kept for ſome days, advanced to putrefaction without any further ſeparation.

The circumſtance of its being longer in coagulating led Mr. Hey to imagine that it was owing to the

the ſerum being diffuſed through the craſſamentum.

It is a curious circumſtance that blood taken in different cups from the ſame perſon and at the ſame time, will differ very conſiderably in the proportion of this ſize. Mr. Hewſon thought and with great probability that it was owing to the manner in which the veſſels are acting at the time when the different portions are drawn off; for the action of the veſſels is encreaſed by inflammation, and as the action of the veſſels decreaſes, the ſizy appearance becomes proportionably leſs. If twelve ounces of blood is taken in three cups, the firſt will have little or no appearance of buff, the ſecond a good deal, and the third leſs.

That the firſt has no ſize upon it, may be owing to the apprehenſions of the patient; fear being known evidently to diminiſh the action of the veſſels, ſometimes occaſioning ſyncope, and even death.

death. That this depends in a great meaſure on the action of the arteries may be further proved by bleeding an animal to death; and in operations it has been a frequent obſervation, that the blood coagulates ſooner in proportion as the patient becomes faint.

Size will ſometimes appear when there exiſts no real inflammation, but only an increaſed action of the arteries, as is evident from the blood of pregnant women; which if drawn in a full ſtream and ſuffered to ſtand till it coagulates, always exhibits an appearance of buff upon its ſurface: but when the quantity is conſiderable we may reaſonably infer that the blood has ſome inflammatory tendency.

This gluten was conſidered by many phyſicians as a preternatural and morbid matter, but we now very certainly know, from many inconteſtible proofs, that it is conſtantly a conſtituent part of the human blood, and that it is produced ſolely

by a peculiar ſeparation of the parts of the blood, effected in conſequence of inflammation and ſome other circumſtances, giving riſe to the appearance which was erroneouſly conſidered as a mark of a morbid lentor in the blood. That ſuch a preternatural lentor does ever prevail in the general maſs of blood, we have no direct proofs of; the experiments of Dr. Browne Langriſh on this ſubject, afford no concluſion, having been made on certain parts of the blood ſeparated from the reſt, without attending to the different circumſtances of blood-letting, which we have already remarked have great influence on its ſeparation and concretion.

It is well known that all the animal fluids, but eſpecially the gluten, is inclined to putrefaction; and that even in the living body if freſh aliments be not very conſtantly taken in: and that alſo if certain excretions which carry off noxious or putreſcent matter, be not duly ſupported, a conſiderable tendency to putrefaction takes place.

Hence

Hence Dr. Cullen ſuppoſes that ſome degree of putrefaction exiſts very continually, even in the moſt healthy ſtate of the animal; and that it appears moſt evident in an evolution of ſaline matter, which being taken up by the aqueous parts conſtantly preſent, forms the ſeroſity, and that the ſerum which is obtained by ſpontaneous ſeparation, conſiſts of a portion of gluten diſſolved in this ſaline fluid*.

It would appear, from the name of *ductus aquoſi* given to the lymphatic veſſels, that their firſt diſcoverers ſuppoſed the lymph to be mere water.

This opinion was rendered more probable by ſome of the ſucceeding phyſiologiſts, and particularly by the learned Boerhaave, who ſuppoſed that there were three ſeries of arteries: the *ſanguiferous*, carrying true red blood, the *ſeriferous*, carrying the ſerous parts without the red globules, and the

* Vide Cullen's Inſtitutions of Medicine.

lymphatic,

lymphatic, which had each their correſponding veins deſtined to reſtore their particular fluids to the heart.

Thence the lymph ſeems to have been concluded the thinneſt part of our fluids; which opinion was confirmed to phyſiologiſts by Leuwenhoeck's theory, that the globules of lymph were ſmaller than either thoſe of the ſerum, or of the red parts of the blood.

The fluids that moiſten the different cavities of the body, as of the peritoneum, pleura, pericardium, &c. having been ſuſpected to be formed ſolely from the condenſation of that ſteam which iſſues from the opening of animals juſt killed, have thence been conſidered as mere water by ſeveral anatomiſts and phyſiologiſts, who imagined their opinions confirmed, by obſerving, that in dropſies, where a large quantity of fluid is diſcharged from ſuch cavities, it is generally mere water, very rarely coagulable by expoſure to air,

or

or the influence of heat; and agreeably to this opinion they ſuppoſed, the fluids, ſupplied by nature for the moiſtening of theſe cavities muſt be the ſame as thoſe evacuated from them in dropſical caſes.

But however plauſible the arguments from which ſuch concluſions were drawn, it appears from experiment, that notwithſtanding their tranſparency in living animals, and their being ſo *watery* in caſes of dropſy, yet in the healthy ſtate of animals they differ ſo eſſentially from pure water as not only to coagulate when expoſed to heat, but alſo by mere expoſure to air; and in this circumſtance they are perfectly analogous to the coagulable part of the blood called the *coagulable* lymph; as is evidently demonſtrated by collecting this fluid from the ſurfaces of the abdomen, thorax, pericardium, &c. of an animal that has been recently killed, while in a ſtate of health; for if the fluid thus collected be ſuffered to reſt, it will take a concrete

concrete form, as the coagulable lymph of the blood does, by expoſure to air.

This is an experiment which Mr. Hewſon made on a very conſiderable number of animals, as on bullocks, dogs, geeſe, and rabbits; nor did the reſult of any of the experiments differ.

From among thoſe who concluded theſe fluids to be a mere water, ſhould be excepted Drs. Haller and Monro, who are of a different opinion.

If immediately after killing an animal in health, a lymphatic veſſel be properly ſecured by ligatures, ſo as to prevent the eſcape of its contents, and then cut out of the body and opened, ſo as to let out the lymph into a cup or other veſſel, and expoſe it to the air, it will become gelatinous, as the coagulable lymph of the blood would do, under ſimilar circumſtances. This experiment Mr. Hewſon has alſo made ſeveral times, and we have

have frequently repeated them with ſimilar reſults, on dogs, aſſes, and geeſe.

Since then thoſe fluids in healthy animals coagulate ſpontaneouſly on expoſure to air, may we not conclude that they are the ſame as the coagulable lymph of the blood, at leaſt they would ſeem more eſpecially of that nature, than either the water, or the ſerum, which latter do not coagulate on being expoſed to the air? and it would appear an argument much in favour of this inference, that ſuch a fluid ſeems better adapted to the purpoſe of lubrication than *mere water*, and more perfectly analogous to the *ſynovia*, which of all fluids is the beſt fitted for that purpoſe?

Although from theſe, and other experiments of a like nature it would ſeem ſufficiently evident, that the lymph in the different cavities and veſſels of an healthy animal, will always coagulate on expoſure to the air, yet it is equally certain that the conſiſtence of that coagulum will vary in different

ferent animals, and even in the ſame animal according to the different circumſtances of health; nor will the differences of time required for their concretion be leſs obvious; inſtance, theſe fluids in *geeſe* will coagulate ſooner than thoſe in dogs.

Mr. Hewſon remarks that in moſt of the dogs which he examined, the lymphatic fluids formed a ſtrong jelly; but in a dog which he had fed eight days with bread and water only, and that too ſomewhat ſparingly, this jelly was but very weak.

That age has ſome influence on the concretion of theſe fluids, would ſeem fully confirmed by obſerving that in young animals, as geeſe, &c. the coagulation does not take place ſo ſoon as in ſuch as are full grown, nor is this obſervation leſs juſt with reſpect to the fluid contained in the pericardium and abdomen of other animals; which fluid when in a ſmall quantity, perhaps *always*, forms a ſtrong jelly; while on the contrary if it be in a conſiderable

conſiderable quantity, and the animal in a feeble or debilitated ſtate, it will be found proportionably thinner.

In dropſical caſes, the fluid evacuated from theſe cavities, has, I believe, very rarely been obſerved to coagulate on expoſure to air, as the fluids natural to thoſe cavities would do in a perfectly healthy ſtate of the animal.

In ſome caſes it has been found capable of coagulating by heat, like the ſerum of the blood, while in others it has undergone no further alteration than that of becoming ſlightly turbid though boiled for a conſiderable length of time.

Though we have ſaid it rarely happens, that theſe fluids, collected in any very conſiderable quantity, and through the influence of diſeaſe, are capable of coagulation, by expoſure to air, or without the application of heat, yet do we not mean to infer, that this can *never* take place; on

the contrary we *have* ſeen, more than once, the fluid evacuated from an *aſcites* by the operation of tapping, acquire by reſt in a moderate temperature, a truly gelatinous conſiſtence, though in but a *ſlight* degree, as might naturally be expected from the large quantity of water in proportion to the coagulable matter.

We have alſo frequently obſerved when examining the bodies of ſuch as have died labouring under dropſical affections, that a conſiderable portion of perfectly gelatinous matter has been ſeparated from the fluid contained in the abdomen; in a manner very ſimilar to the ſpontaneous ſeparation which takes place in the blood when effuſed from its proper veſſels; and not ſeldom have we found the fluid naturally contained in the pericardium converted into a concrete tremulous jelly.

Although this lymph is more abundantly aqueous in a debilitated ſtate of the animal, yet

is

is it leſs watery and more coagulable in ſome diſeaſes.

But a ſtill more curious fact, is, that in thoſe caſes where the fluid contained in the pericardium and abdomen of animals in different ſtates of health, has been compared with that of their lymphatic veſſels they, were uniformly found to agree with regard to the conſiſtence and degree of coherence of the jelly which they formed.

For when the animal was in perfect health, the lymph from the cavity of the pericardium, abdomen, and pleura, formed a ſtrong jelly, and that in the lymphatics of the neck and extremities was equally firm.

When the animal was reduced, as in the dog, fed *eight days* on bread and water only, or when the gooſe was very young, the coagulum formed by the fluid contained in the cavities of the perecardium, &c. was very weak, and that of the lymphatic veſſels, in the ſame proportion. Hence, although

though theſe fluids may be ſubject to variations according to the different circumſtances of health, yet do they ſeem always to agree with each other.

What would ſeem to confirm our idea with reſpect to the lymph contained in the lymphatic veſſels, approaching very nearly and with very ſlight difference, to the nature and properties of the coagulable lymph of the blood, is their peculiar property of taking a concrete form by expoſure to air, although the former differs from the latter in the time neceſſary for their coagulation.

In dogs of apparent perfect health, whoſe blood and lymph were diſcharged from their containing veſſels at the ſame time, the latter was found to require a much longer time for the proceſs of coagulation than the former.

The time which the blood generally requires to perfect its coagulation ſeldom exceeds *ten minutes**,

* Vide p. 49.

but

but the fluid evacuated from the lymphatic veſſels was found to require upwards of *half an hour* for the completion of that proceſs.

And although in weak animals the coagulation of the blood is more expeditious, yet the contents of the lymphatic veſſels, or the fluids contained in the cavities of the pericardium, &c. ſeem leſs inclined to coagulate in proportion as the animal is reduced, or the fluids become more watery.

The principal differences which are obſerved between the contents of the lymphatic veſſels, and the coagulable lymph of the blood, ſeem to ariſe from the difference of time required for their coagulation, either when expoſed to the air, or when confined from its influence, and merely ſuffered to reſt in their proper veſſels; in the latter caſe however they moſt evidently differ.

In a dog, killed whilſt in apparent health, and whoſe *veins* and *lymphatic veſſels* were ſecured by ligature

ligature immediately after death, the blood in the *veins* was completely coagulated in the courſe of *ſix hours*, whilſt the lymph of the *lymphatic veſſels* remained perfectly fluid, even at the expiration of *twenty hours* after death ; yet on expoſure to air for ſome time it acquired a gelatinous conſiſtence.

We have already remarked that the ſerum of the blood only, forms good pus ; but that in certain caſes the cavity of the pericardium. &c.* has been found to contain a conſiderable quantity of pus, without any appearance of ulcer or eroſion.

Hence in theſe caſes as pus is produced merely by ſecretion, may we not with great probability allow, that even in abſceſſes, where there is a conſiderable loſs of ſubſtance, the pus is not formed from a diſſolution, or melting down of the *ſolids*,

* Vide p. 107.

but

but being ſecreted into the cellular membrane, &c. from its preſſure, or other cauſes, deſtroys the texture of the ſolids and then diſſolves them. This ſeems to be ſtrongly confirmed by an experiment which we have frequently repeated and uniformly with the ſame reſult; to wit, having put a piece of freſh meat, into an ulcer, and covered it up, its texture was ſoon deſtroyed, at the ſame time rendering the pus more fœtid.

And this opinion of pus, being in ſome inſtances at leaſt formed by ſecretion, ſeems more evidently confirmed by obſerving that in its pure ſtate it is full of *globules*, in which circumſtance it bears a reſemblance to milk, which is produced by ſecretion, and not by fermentation.

From what we have ſaid then, it would appear that the lymph contained in the lymphatic veſſels, and the fluids which moiſten the different cavities of the body, as the pericardium, pleura, peritoneum, &c. far from being *mere* water, are in healthy

healthy animals coagulable fluids, very nearly approaching to the nature of the coagulable lymph of the blood, and of which at leaſt it is highly probable they may be a ſpecies, perhaps compoſed of that very lymph in a ſtate of dilution with water; and that the different proportions of the mixture vary from the dropſical habit, where the coagulable lymph is in ſmall, and the aqueous parts in great quantity, up to the highly inflammatory habit, where this lymph abounds, and the water is in leſs proportion; and that even in ſome inſtances the lymph, by paſſing through inflamed veſſels, has been converted into pus.

There is yet another part of the blood, which deſerves our attention perhaps not leſs than any of the former.

It is that *fibrous matter*, called by Malpighi and Gaubius the *fibra ſanguinis*, by Senac the *coagulable lymph*, and by Dr. Cullen the *gluten of the blood*; which when ſeparated ſpontaneouſly from the

the reſt of the maſs, and laying on the ſurface of the blood drawn out of the veſſels of living animals, conſtitutes a principal part of that membranous appearance known to phyſiologiſts under the denomination of the inflammatory cruſt, concerning which we have already delivered our ſentiments*.

This fibrous matter is generated in great abundance from the *craſſamentum*, but from the ſerum in ſmaller quantities. They may be obtained by putting the blood into a linen cloth, and lixiviat-

* Leſt it ſhould be underſtood by what we have advanced with regard to this phenomenon, in a former part of this treatiſe, that the *coagulable lymph* (properly ſo called) was alone inſtrumental in the production of this inflammatory cruſt; we beg leave to obſerve, that it is by its union with the *fibrous matter* that it becomes adapted to that purpoſe; and that perhaps in almoſt every inſtance this fibrous matter is abſolutely neceſſary to its formation. At leaſt there can be no doubt of this, in caſes where the cruſt has acquired any conſiderable degree of tenacity.

ing with a conſiderable quantity of water, until it runs through perfectly clear.

The reſiduum after this ablution ſeems chiefly to conſiſt of a white, fibrous matter, equal in quantity to about the *twenty eighth* part of the whole maſs.

Theſe fibres, having been waſhed, according to the above mentioned proceſs are perfectly white, colourleſs, and inſipid. They are formed from the coagulable lymph but are not generated in the courſe of circulation, ſince in blood recently drawn from the living animal, and before it has begun to coagulate, theſe are not to be perceived by the microſcope, which ſō eaſily renders viſible the moſt minute red globules: nor does their long thread like figure ſeem adapted for receiving motion.

By diſtillation on the water bath, they give over an inſipid phlegm, of a faint ſmell, and which readily putrifies. This fibrous matter hardens in

a ſingular manner by expoſure to the moſt gentle heat; and when ſuddenly preſented to a ſtronger hear, it ſhrinks up like parchment.

It affords by diſtillation in a retort, an alkaline phlegm, a ponderous, thick oil of an abominable fœtid ſmell, and a conſiderable quantity of ammoniacal chalk contaminated with oil; the reſidual matter is a denſe, heavy coal, of no great bulk, and much more eaſy of incineration than that of the lymph; the aſhes are perfectly white, apparently earthy, ſeeming to conſiſt chiefly of phoſphate, and do not contain the ſmalleſt portion either of ſaline matter or of iron, being deprived of both theſe ſubſtances by the previous lixiviation.

Theſe fibres advance rapidly and with great facility to putrefaction; when ſubjected to the influence of a hot and moiſt air, they ſmell, and afford volatile alkali in conſiderable proportion. It is totally inſoluble in water, and when expoſed

to

to a boiling heat in that fluid, it indurates and assumes a greyish colour. Alkalies are incapable of effecting its solution; but the most feeble acids combine with it.

Mr. Berthollet has observed, that in its union with nitrous acid, a considerable quantity of mephitis is disengaged, and afterwards nitrous gaz, the solution being accompanied with effervescence; when this gaz is set at liberty, oily and saline flocks may be observed floating in the residuum, which is a yellowish fluid; this liquor by evaporation affords crystals, analogous to the acid of sugar or oxaline acid, and deposits a very considerable quantity of flocks formed of a peculiar oil and calcareous phosphate.

The fibrous part of the blood seems to contain two oils, one, which with the oxegynous principle, constitutes the oxaline acid, the other with the same principle forming the malusian acid. The muriatic acid dissolves the fibrous mat-

matter, forming therewith a greeniſh jelly. It is diſſoluble in vinegar by the aſſiſtance of heat. It is precipitated from the acid ſolution by alkalies, and even water, no longer exhibiting the ſame properties, after being ſeparated from theſe acid menſtrua; being decompoſed in combination with thoſe ſolvents.

It is not altered by the admixture of neutral ſalts, or other mineral ſubſtances. It readily combines with lymph, than which it is a more perfectly animalized ſubſtance. This animal gluten greatly reſembles that of flour, but it poſſeſſes in a much more eminent degree the remarkable property of becoming concrete by cooling and reſt.

It will appear evident from what has been advanced, that this matter is of the utmoſt importance in the animal œconomy and that many very uſeful facts of no inconſiderable conſequence in practice may be derived from a more ſcrutinous atten-

attention to this ſubſtance than hath hitherto been paid by phyſiological or pathological writers.

It has been long ſince obſerved that, it is formed from a diſpoſition of its original matter in the muſcles, conſtituting the fibrous baſe of thoſe organs, and compoſing that ſubſtance which is moſt eminently irritable. Hence it may be infered that it is capable by its abundance or deviation, of giving riſe to many and peculiar diſorders*.

By the foregoing obſervations on the fibrous matter we have ſhewn it to conſiſt principally of a gelatinous gluten, and a certain terreſtrial ſubſtance.

Theſe elementary particles begin to cohere, even while the fluids are in *ovo*, and ſoon acquire

* Vide a memoir of M. de Fourcroy's in the volume of the Royal Society of medicine for 1783.

their

their fibrous or thread-like appearance. And on the different proportions of the terreſtrial and gelatinous matter neceſſary to the formation of the ſimple fibre depends the various degrees of hardneſs and ſoftneſs in the different parts of the body ; and from the firm coheſion of theſe parts, or the defect therein, Boerhaave deduces the general ſource of diſeaſes*.

Although it is not our intention here to treat of diſeaſes with their ſeveral cauſes, and the modes of cure ; yet would it not ſeem irrelavant that we ſhould make ſome curſory remarks on that ſtate of the body induced by a laxity of the animal fibre called by Dr. Fordyce the general weakneſs.

He obſerves that this may be divided into two kinds. The firſt in which both ſenſibility and irritability are encreaſed : the ſecond in which

* Vide Boerhaave's aph. and Haller's Element: Phyſiolog. on the animal fibre.

theſe

theſe ſenſations are conſiderably diminiſhed; as in apoplexy and palſy.

The *firſt* is called ſingle weakneſs, and may again be ſubdivided into two varieties; firſt, when by any means it is ſuddenly produced, and in which caſe it is in general eaſily reſtored.

Secondly, when it comes on ſlowly, and in which caſe it is with difficulty reſtored.

Hence theſe two differ eſſentially; both as to their cauſes, ſymptoms, effects upon the ſyſtem, and the mode of cure. The ſecond is called a paralytic weakneſs.

Weakneſs may be induced by various means, thus, bleeding, all evacuations when too copious, and continued for too great a length of time, by leſſening or exhauſting the living power, produce this effect.

A particular part may be weakened by exciting a ſecretion from the mucous gland of that, or contiguous parts, though not connected with it.

The ſyſtem may be ſtrengthened by various means, firſt, by *nouriſhing* and *ſtrengthening* diet, which if the veſſels have been ſuddenly emptied, ſhould be adminiſtered freely, for the veſſels are capable of receiving as much as the power of the conſtitution can eaſily digeſt; and by this means the ſtrength is ſoon reſtored. If the diſeaſe has come in a more ſlow and gradual manner, the influence of good nutritious food will not be ſo ſpeedily exerted; for any conſiderable debility of the organs of digeſtion, brought on gradually, renders the proceſs of digeſtion by far more difficult and ſlow; in ſuch caſes proper food, exhibited in moderate quantities, and frequently repeated, has often proved extremely beneficial.

The arteries ſometimes, have a conſiderably increaſed action in hectic fevers: thence it becomes

neceſſary ſometimes to diminiſh the degree of contraction, by blood-letting; and then the patient may be capable of receiving nouriſhing diet, not only without inconvenience, but even with manifeſt advantage.

When the ſtomach is in a weak ſtate we ſhould cautiouſly avoid thoſe vegetables that produce acidity in the primæ viæ; hence cabbage, beans, peas, &c. are by no means proper; but the farinaceous ſeeds, properly prepared and given in conjunction with animal food, are beſt.

Secondly, the body may be ſtrengthened by exerciſe. When exerciſe is uſed it ſhould not be to exceſs, but ſhould be equal and univerſal through the whole body, and not in any one part more than another; and on this account, riding in a carriage, &c. is much preferable to any other, as the motion of the body is more equal; but in caſes where more violent exerciſe is required, riding on horſeback will be of great ſervice.

Exer-

Exercise ſhould always be taken in as free and pure air as poſſible; for thus the circulation is increaſed and becomes more free, paſſing through the lungs without any obſtruction; whereas in a moiſt air the lungs are always more or leſs obſtructed, and anxiety, &c. is produced.

It is perhaps equally neceſſary, in moſt inſtances, that the kind of exerciſe ſhould be pleaſing or agreeable to the patient—that the mind may be open to pleaſureable affections.

Thirdly, the ſtrength may be encreaſed, or reſtored by means of cold, which contracts the extreme veſſels, and hence the more internal ones about the precordia, are kept filled, which tends very conſiderably to the preſervation of ſtrength.

It moreover diminiſhes the irritability of the ſyſtem, and prevents people from ſo readily ſuffering by expoſure to cold.

If

If the cold be very ſuddenly applied, it contracts the extreme veſſels in too great a degree, by which the more interior ones become overloaded, and febrile diſeaſes, &c. ſupervene. Hence expoſure to cold ſhould be gradual, that is, it ſhould be by living very continually in a cold atmoſphere, yet ſhould it not be too conſiderable, though applied ſlowly, for its powers of exhauſtion are capable of producing weakneſs, numbneſs of the limbs, anxiety, &c. this however depends upon the degree of cold to which the animal has been habituated. But in no caſe ſhould the tranſition from heat to cold, or from cold to heat be ſudden.

The *cold bath* has been uſed for the purpoſe of ſtrengthening the ſyſtem, but it would ſeem a very uncertain remedy; for as we have already remarked a very ſudden expoſure to cold contracts the extreme veſſels too much, keeping the more interior ones filled, ſo that after the patient comes out, the heart acts with greater force and propels

it

it again upon the skin, producing ſweat; and by this a kind of paroxyſm is brought on.

It is no doubt in ſome caſes of very conſiderable ſervice; but in diſeaſes attended with debility, and where there are conſiderable ſecretions, as in gonorrhea benigna, &c. the diſcharges are ſometimes reproduced, inſtead of being taken off.

A temperate bath, in which is diſſolved a quantity of aſtringent ſtubſtances as ſea water, &c. acts as an aſtringent on the skin after the patient comes out, and frequently ſtrengthens the ſyſtem.

Cold climates have a much greater tendency to ſtrengthen the habit, than the warmer ones, as in the former the denſity of the atmoſphere, renders reſpiration more ſalutary and free.

Fourthly, the ſyſtem may be ſtrengthened, by the patient being ſituated ſo as to breath properly,

and

and inſpire ſuch air, and in ſuch quantity as is neceſſary for the welfare of the animal œconomy.

There are two effects of conſiderable importance produced by reſpiration on the blood; firſt, by propelling it through the lungs, ſo as to prevent its accumulation in the right ſide of the heart; and in the ſecond place, by what it imparts to, and receives from the blood, its colour is changed from a dark to a more florid red*.

The want of *pure air* induces anxiety, &c. which is ſoon followed by weakneſs; thoſe who live in large and populous cities or towns, are infinitely more ſubjected to diſeaſes ariſing from debility, than thoſe who live in the country or villages thinly inhabited; in which latter they are generally more robuſt, and ſubject rather to inflammatory complaints; notwithſtanding a cool air generally

* We have already ſpoke ſomewhat largely on this ſubject, and to which we muſt refer the reader.

con-

conduces to the increaſe of ſtrength, when the patient is exhauſted by profuſe evacuations, yet by ſending them into the country the purer air there may too much accelerate the circulation ; and as the large veſſels at this time contain but a ſmall quantity of blood, ſuch a degree of weakneſs may be brought on as to eventually deſtroy the patient.

Medicines are the next means of reſtoring ſtrength. Theſe are ſuch as invigorate the ſolid, principally by encreaſing the living power; of this ſort are camomile, gentian, wormwood, peruvian bark, and ſome other of the vegetable bitters.

Various mineral productions are frequently found uſeful in reſtoring the tone of the ſyſtem ; among the metals *iron* is found to be peculiarly adapted to this purpoſe.

All theſe diminiſh irritability at the ſame time that they give tone to the relaxed fibres.

In

In thoſe caſes where the ſyſtem hath been very ſuddenly weakened, but not ſo much ſo as to impair either the appetite or organs of digeſtion, a nouriſhing diet will often ſuffice, without the adminiſtration of thoſe remedies. If, for inſtance, a patient is much reduced by a fever, and ſome ſlight inflammatory ſymptoms remain, it is better to omit theſe medicines; but if any conſiderable degree of fever is ſtill preſent, with want of appetite, colliquative purges, &c. and the ſtrength does not return, we may uſe them with advantage; and if debility be ſuddenly induced, attended with partial evacuations they may be eſpecially ſerviceable, and perhaps none more ſo than the *peruvian bark*.

When weakneſs is gradually brought on, theſe medicines may be employed with very conſiderable advantage, if ſuitable precautions are not neglected.

Firſt, in melancholic temperaments where there is

is eventually a contraction of the veſſels, as well as a weakneſs, indicated by a hard pulſe; but before we employ them it would be neceſſary to take off this diſpoſition to contraction by evacuations. However it frequently happens that in melancholic habits, we cannot by any means employ them.

2. They are apt to loſe their influence on the ſyſtem, by uſe; for if you adminiſter them for a certain length of time, their effects will at firſt be fully produced, and the patient ſeem to be very much relieved, but their effects will ſoon diminiſh by continuance, until they are, in a manner, loſt; for this reaſon it is perhaps better to vary the medicine; giving the bark and ſteel alternately, and occaſionally leaving them off for a time, ſo as to prevent their becoming habitual to the patient, who after a ſmall time, again repeating them, will derive conſiderably more benefit from their uſe, andhis ſtrength will more ſpeedily be reſtored.

When debility ſupervenes ſlowly, and in con-

ſequence of lingering diſeaſes, it is in general better to exhibit other bitters and ſtrengtheners than the bark.

In moſt caſes when the moving powers are in a lax and debilitated ſtate, preparations of iron are preferable to either the bark or bitters; but where a ſtimulus is wanting to the ſyſtem, they can be of little ſervice.

Iron may be exhibited with moſt advantage in a ſtate of ſolution, we ſhould however remember, that ferruginous preparations are ſeldom admiſſible in melancholic habits, ſince their ſtimulant or aſtringent powers are apt to produce coſtiveneſs.

We ſhould always cautiouſly avoid giving tonic medicines for this diſeaſe in too large doſes, otherways they will only tend to aggravate the complaint*.

* Vide Edenb. Med. Com Vol 4, p. 339—413.

Having

Having taken notice of the diſeaſe ariſing from a laxity of the *fibre*, it may not be leſs important to add ſome curſory obſervations on the phenomena of irritability in which the fibrous parts are a very principal inſtrument; and although there have been many abettors of the opinion, with regard to the fibres of the perioſtium, tendons, and ligaments being devoid of ſenſibility*, yet we now very certainly know that the phenomena of inflammation render manifeſt the irritability and ſenſibility of parts, which in an healthy ſtate did not ſeem to be in poſſeſſion either of the one or the other.

Many and various have been the opinions of phyſiologiſts on this ſubject†. The three noted claſſes of animal powers, *elaſticity*, *irritability*, and *ſenſibility*, have been and are yet too much confounded, although it is no difficult task to diſtin-

* See the works of Drs. Haller and Hunter, De Hean, &c.

† Vide Haller, Whytt, De Hean, Kirkland, Cullen and others.

guiſh

guiſh theſe affections of the fibres from one another.

The force and nature of elaſticity, poſſeſſed by the fibres, which, only in degrees, prevades all parts without exception, was fully known to Bellini, Baglivi, Stahl, Pacchioni, Juncker, &c. This power known to Stahl's followers under the appellation of tone, has no ſimilarity to irritability, ſenſibility and vital powers, ſo called; it does however, either alone perform the action of the animal and vegetable body, or adds ſtrength and vigour to them; the former is manifeſt in the motion of the ribs and cartilages, and the latter in the conſtriction of the uterus, veſſels, and membranes.

It is by no means ſubject to the laws of life only, but may continue even for a conſiderable time after death; nor is it completely deſtroyed but by putrefaction alone. It may during life be diminiſhed by various cauſes, and again be reſtored by ſeveral remedies.

Irri-

Irritability, which Haller thought exiſted in the fibres of the muſcles alone, in name indeed but not in reality, and which was known to Gliſſon, is a new genus of animal power; nor does the word *enormoun* of Hippocrates ſignify the ſame thing. It would ſeem almoſt proved by the experiments of Lups, Haller, Fontana, Hoffman, and ſeveral others, that it is different from elaſticity in its riſe, duration, ſeat, cauſes, effects, and phenomena. Wrisberg remarks, firſt, that it is moſt powerful in the muſcular fibres of the whole body but not equally diſperſed through all; more powerful in the heart, muſcles of reſpiration, and inteſtines; becomes gradually weaker among the voluntary muſcles, and perhaps, remains but in a trivial degree in the veſſels, and membranes; but however ſome always exiſts, as appears from the doubts offered by Whyt, De Hean, Van Doeveren, &c. which have been anſwered by Haller, and the learned Cigna.

Secondly, the phenomena of irritability and irre-

irritation, themſelves, by which thoſe are produced, do not always agree; for in ſome it advances in a regular tract, ſo that from the ſlighteſt irritation you will always obſerve a manifeſt irritability; This is nearly the caſe in all the muſcles.

In many other parts you may obſerve, the greateſt inconſtancy, and irregularity of effect; being one thing to day, another to-morrow; now encreaſed, now diminiſhed, at one time yield to, at another reſiſt, the irritating power: all which is evident in the skin, viſcera, veſſels, and iris.

Thirdly, the learned pathologiſts Eller, Tiſſot, Gerhard, have long ago acknowledged the very great riſe of the doctrine of irritability. It would be of great importance to be well acquainted with the remedies, whether they be medicines, or remedies from diet, or otherwiſe, which particularly conduce to excite irritability, if it is languid, or to diminiſh it if it is too great.

Opium

Opium and the other narcotics, camphor, cantharides, acrid poiſons, bark, and the electric ſpack, ſhew a clear influx of animal ſpirits in the production of irritability.

Fourthly, That it is different from the faculty of feeling, and therefore by no means dependent on the *nerves*, appears from the irritability of vegetables, and from other reaſons. The faculty of feeling, depending ſolely upon the nerves, although it has been regarded as one and the ſame thing with irritability, has been more ſtrongly oppoſed by Haller's opponents, De Haen, Whytt, Le Cat, Gerhard, &c. than irritability itſelf. But according to Haller's and Caſtell's experiments, that ſenſibility of parts is to be refined both to the various quantity of the nerves, their ſituation and condition, and to the various violence of irritation, and nature of the irritating or offending body, ſo that they may be at times more or leſs painful; and at other, as Haller thinks, they may be altogether inſenſible.

We

We ſhall not repeat what has often been objected to, that a greater pain having preceded, abſorbs, or blunts a leſs pain following; as we are not ſenſible to the taſte of a drop of wine having taken a very ſmall quantity of rectified alcohol upon the tongue a little before.

It cannot however be denied, that in inflammatory diſeaſes, affections of the mind, and other cauſes, it may happen that hurt parts may now feel, which under any other condition might ſeem to be inſenſible.

The *vital power* of certain learned, and more modern authors, as Vanden Bos, Bikker, Gaubuis, Albinus, &c. ſeems rather to be compounded of all the animal powers comprehended together: which opinion except in ſome minutiæ, the great Boerhaave and Simpſon have more exactly adapted*.

* Vide Profeſſor Wriſberg's notes on Haller's Element. Phyſiolog.

Per-

Perhaps no theory has ever been advanced on the laws of irritability equal to that of the learned Girtanner, whoſe memoir on the laws of irritability, &c. is ſo elegantly tranſlated in Dr. Beddoe's obſervations, that we ſhall give an abſtract from it *verbatim*.

" The irritable fibre, he ſays, from the firſt moment of its exiſtence to that of its deſolution, being conſtantly ſurrounded by the body which acts upon it, and ſtimulates it, and upon which it re-acts by its contraction, it follows, that during the period of its exiſtence the irritable fibre is in continual action; that its exiſtence conſiſts in action; and that it is not a paſſive ſtate as ſome authors have aſſerted.

" Hence, external objects having no immediate action upon the nerves, and only acting upon them, and producing their different ſenſations through the medium of the irritable fibre, it is plain that the ideas we have of external objects are not

conformable to thoſe objects, but that they are varied and modified by the irritable fibre through which they are tranſmitted to us.

"Objects therefore appear different according to the different ſtates of the fibres. The irritable fibres which are combined together in every individual, whether animal or vegetable form a ſyſtem of fibres, in which the integral parts act continually upon the whole, while the whole reacts upon the parts, ſo that every ſtimulus which acts upon any fibre in the ſyſtem will deprive it of part of its irritability; but this loſs will ſoon be repaired by the ſyſtem, and every fibre will furniſh in proportion, ſome ſhare of its own irritability to ſupply the loſs in any one fibre. Thus it is that a very weak ſtimulus, but one that is conſtantly acting upon one part of the ſyſtem, ſuch as ſlow poiſons, the abuſe of ſpiritous liquors, &c. exhauſts in the end the whole ſyſtem, and produces death.

"For

"For the ſame reaſon a very powerful ſtimulus applied to one part of the ſyſtem, ſuch as laurel water, opium, the poiſon of the rattleſnake, will in an inſtant exhauſt all the irritability of the ſyſtem, deſtroy the animal, and leave the fibres without any irritability.

"I am convinced, ſays he, from repeated experiments, that opium, alcohol, ammoniac, a ſolution of ſugar of lead, ſulphuric æther, deſtroy animals by exhauſting the irritability of the whole ſyſtem, and that the muſcles of the animals deſtroyed, have, by application of theſe ſtimuli, been wholly deprived of their irritability*.

* Dr. Beddoes remarks, and we would think very juſtly, that it is incredible that many poſitive ſtimuli, ſuch, for inſtance as the vegetable poiſons of the tropical countries; and the venom of certain ſerpents, which produce death in quantities ſo aſtoniſhingly minute, ſhould, as Dr. Girtanner imagines exhauſt the irritable principle, by combining with it directly themſelves; nor could alcohol, opium, and oil of lauro ceraſus, be ſuppoſed to attract from the irritable fibre, (if we conſider only the quantity in which they produce their

"The

" The effect was the same when these stimuli, were applied to the muscles and stomach, and when injected into the veins of animals.

" The irritable fibres in the same system have not all the same degree of irritability, they have different degrees of *capacity* for the irritable principle. The capacity of the fibres is in the ratio of their distance from the heart. Those equally distant have the same capacity. Every stimuli which affects one of the fibres affects the others at the same time and in the like manner.

" Hence the sympathy of different and separate parts, and those surprising phenomena which hitherto have been explained by the harmony of the nerves, although we see the same phenomena in the vegetable kingdom, which is deprived of nerves.

effects,) a large quantity of oxygene. But supposes it more likely that they occasion a *new combination* of oxygene, throughout the whole system.

" These

" Theſe ſympathetic phenomena are obſervable throughout organized nature. Whatever part of the polypus be touched the whole will contract; and its arms will contract themſelves by ſympathy. If a worm be touched with the point of a pin, without wounding it, the whole worm will be ſeen to contract itſelf; which is a certain proof that the different parts are affected by ſympathy.

" If the ſlighteſt impreſſion be made on one of the leaves of the averrhoa carambola, not only that leaf but all the neighbouring ones will contract themſelves by ſympathy.

" When the irritable fibre has loſt its tone, and fails, either from an acceſs of the irritable principle, or from a deficiency of this principle, it is diſeaſed and the ſyſtem of which it forms a part ſuffers and becomes diſeaſed, through ſympathy. All the diſeaſes of animals may be ranged under two heads; to wit; firſt, the *diſeaſes of accumulation* cauſed by the accumulation of the irritable principle

ciple and the diminiſhed action of the habitual ſtimuli.

"Secondly, the *diſeaſes of exhauſtion* cauſed by a defect of the irritable principle proceeding from the encreaſed action of the habitual ſtimuli, or from the addition of new ſtimuli. Under theſe two claſſes may be ranged all diſeaſes whatſoever.

"Paradoxical as this propoſition muſt neceſſarily appear to thoſe who have not reflected on the ſubject, it is nevertheleſs true, and I ſhall give the moſt convincing proofs of it in a work I am about to publiſh."

"Remedies remove the diſeaſe by their action upon the irritable fibre, and by exhauſting its irritability, when the diſeaſe is that of accumulation or by diminiſhing the action of the common ſtimuli and conſequently by preventing a total exhauſtion, where the diſeaſe is that of exhauſtion.

The

The effects of poiſons are to be explained in this way.

" Poiſons, remedies, and in general all ſurrounding bodies acting only on the irritable fibre, it follows that they act upon the ſyſtem in a ſimilar manner, and that every ſubſtance capable of producing the greateſt poſſible effect upon the fibre, that is to ſay, every ſubſtance capable of exhauſting all the irritability both of the fibre itſelf and of the ſyſtem in an inſtant; as for inſtance, laurel water, or white arſenic, is alſo capable of producing all the inferior degrees of action, either by acting upon a fibre leſs irritable, or by acting upon the ſame fibre, but in a leſs quantity.

" Laurel water, opium, white arſenic, ammoniac, are of courſe both medicines and poiſon, capable of healing as well as of producing all maladies whatſoever without exception.

This

" This truth ſeems to be of the utmoſt importance; and the Abbè Fontana, who made more than ſix hundred experiments to prove that ammoniac is no remedy againſt the bite of a viper, would have ſaved himſelf a great deal of trouble, had he been acquainted with it*.

" If inſtead of applying the venom of the viper to ſo many animals, and afterwards applying ammoniac to the wound, he had made a ſingle comparative experiment, and had applied ammoniac to a wound made by a lancet that was not poiſoned, he would have found that ammoniac itſelf, applied in this manner, would have produced a

* What muſt be the ſtate of medicine when the truth of this theory is eſtabliſhed?—The ſtudy of the ſcience will then only in general be proſecuted through motives of curioſity, and a deſire of knowledge, the practical part being neceſſarily confined to ſuch narrow limits, as to occupy the time and attention of but a comparatively, very ſmall number of profeſſional men.—That, that period may arrive, is a conſummation devoutly to be wiſhed.

diſeaſe exactly analogous to that cauſed by the venom of the viper, and, conſequently ſo far from removing the malady, muſt neceſſarily increaſe it by exhauſting the irritability of the fibre in a much leſs time, than the venom of the viper, by itſelf, was capable of doing.

" Mr. Fontana has made upwards of ſix thouſand experiments upon the poiſon of the viper; he employed more than three thouſand vipers, and cauſed to be bit more than four thouſand animals, and the concluſion he drew after this truly enormous number of obſervations was, that the poiſon of the viper kills all animals, and produces the diſeaſe by its action on the blood.

" But why did Fontana neglect to make the deciſive experiment, the *Experimentum Crucis* of Bacon? It is well known that frogs, and many animals with cold blood, live a long time without the heart and entirely deprived of blood. If therefore the poiſon of the viper kills animals by its

action on the blood, it would not deſtroy frogs without blood. But experiment contradicts this reaſoning. The poiſon of the viper will kill frogs without blood in as ſhort a time as it kills thoſe animals that have not loſt their blood.

" It is not therefore by its action on the *blood* that the venom of the viper deſtroys animals; and thus does it happen that a ſingle experiment frequently overturns all that ſix thouſand other experiments have apparently eſtabliſhed.

Dr. Girtanner concludes from his own experiments, that poiſons operate upon the blood juſt as they do upon the muſcular fibre, by depriving it of its principle of irritability, or of its oxygene.

" The effect produced upon the irritable fibre by any ſtimulus, is in a ratio compounded of the degree of irritability of the fibre, and of the force of the ſtimulus. The ſame ſtimulus will produce

greater

greater contractions upon a fibre more irritable, than upon one leſs irritable; and the irritability of the fibre being the ſame, it will contract itſelf more upon the application of a ſtronger than of a weaker ſtimulus.

" The effect produced upon an irritable fibre by any ſtimulus is in the inverſe ratio of the repetition of its application. Cæteris paribus, the effect of any ſtimulus diminiſhes every time its application is repeated, till at laſt the effect is nothing, or = o.

" This explains the phenomena of habit, and many other phenomena hitherto inexplicable in the animal and vegetable œconomy. The mimoſa pudica, for example, expoſed to a ſtrong wind, contracts itſelf; but it ceaſes to contract itſelf in obedience to this ſtimulus after it has been accuſtomed to it.

" The effect produced upon the irritable fibre by any ſtimulus, is in a ratio compounded of the degree of irritability of the fibre, and the degree of the force of the ſtimulus directly, and the degree of the habit of the fibre, inverſely. Let the force or intenſity of the ſtimulus $= a$, the degree of irritability of the fibre $= b$, the degree of the habit of the fibre $= c$, then the effect produced upon the fibre or x will $= \frac{a\,b}{c}$. But all the ſtimuli acting in the ſame manner, that which diminiſhes the irritability of the fibre for a certain ſtimulus, will in like manner diminiſh it for the ſtimulating force in general, wherefore the habit of the fibre is comprehended under its degree of irritability, or c is comprehended under b. Therefore x will $= a\,b$.

" The effect produced upon the irritable fibre by any ſtimulus or x being always equal to $a\,b$, it follows that the value of a and b being known, the value of x is alſo known. But admitting an unity fixed and conſtant, it will be eaſy, in all caſes,

to

to expreſs by numbers, the degree of irritability of the fibre, and the degree of the force of the ſtimulus, or the value of *a* and *b*, conſequently it will be eaſy to find the value of *x*.

" All the art of medicine then conſiſts in finding the value of *x*, that is to ſay, in finding a ſtimulus adequate to reſtore the tone of the fibre.

" Thus, if theſe principles be true, phyſic, which at preſent is an art of mere conjecture, will be reduced in time to the certainty of calculation, and after tables ſhall be formed to expreſs the valves of *a* and *b*, and the ſigns by which they may be known, this calculation will be ſo ſimple and eaſy, that it will form a part of the education of every individual. But further, the irritable fibre being the ſame in all organized nature, diſeaſes and their remedies will of courſe be the ſame for all organized beings; there will then be no diſtinction between medicine, farriery, and agriculture, but all theſe ſciences will be confounded and become

one

one, under the general name of *univerſal phyſiology*.

Theſe ſtimuli which I call common and habitual, becauſe they act continually more or leſs upon the irritable fibre, are, *heat*, *light*, *nouriſhment*, *air*, *the circulation of the blood*, *the ſtimulus of generation*, and *the nervous ſtimuli*.

So long as the action of theſe ſtimuli is in proportion to the degree of irritability of the ſyſtem, and the ſum of their action is nearly equal to the ſum of the irritable principle abſorbed by the lungs and diſtributed by the circulation, the whole ſyſtem will be in proper order, and the conſtituting fibres will have their tone.

When one or more of theſe ſtimuli act more powerfully than ordinary, or the fibre becomes more irritable, while the degree of the action of the ſtimuli remains the ſame, the *exhauſtion* of the

ſyſtem

ſyſtem, and one of the diſeaſes in its train, will be the conſequence.

The abſence of one or more of theſe ſtimuli, will produce an *accumulation* of irritability in the ſyſtem, and give birth to one of the diſeaſes of this claſs. I ſhall ſpeak of theſe ſtimuli, ſeparately, in order that I may be better able to explain myſelf.

Of heat—The heat of the atmoſphere and of all ſurrounding Bodies, acts upon the fibre and ſtimulates it. I am convinced of the ſtimulating action of heat from direct experiments. I have expoſed ſmall animals, ſuch as cats, dogs, rabbits, &c. in covered veſſels, to the heat of boiling water, which ſurrounded the veſſel in which the animal was placed, ſo that the water could not touch it. Animals deſtroyed by heat in theſe experiments, upon diſſection, have been found to have loſt all their irritability. Their heart and muſcles contracted themſelves but feebly, even upon the appli-

application of the ſtrongeſt ſtimuli, ſuch as electricity.

It is proved, by ſome beautiful experiments of Mr. Hope, that heat acts as a ſtimulus upon plants; and it is obſervable that plants expoſed to the ſun are larger and produce more flowers and fruit than thoſe which are leſs expoſed to heat. Trees in general are more luxuriant which grow in the ſouth than thoſe in the north. This is a proof that heat is a ſtimulus to the irritable fibre.

The diſeaſes of hot climates are all the diſeaſes of exhauſtion, cauſed by the two powerful action of the ſtimulus of heat. Hence the cuſtom of taking ice in hot countries to reſtore the tone to the fibre, by abſorbing the heat and preventing its ſtimulating action.

The irritability of the hedyſarum gyrans is exhauſted by the heat of the noon day ſun, according to the obſervations of M. Brouſſonnet; and by

by the experiments of M. Fontana, and M. Medicus it is proved that, the the irritability of plants is great in the morning, dimiſhed during the heat of the day, and little or none in the evening.

Of cold—"Cold being of a leſs degree of heat, its effects upon the irritable fibre are in proportion to the habit, or the quantity which is neceſſary to the fibre to preſerve its tone. The animals and plants of hot climates, that require the ſtimulus of a great heat to preſerve the tone of their leſs irritable fibres, are affected by the leaſt obſtruction of this habitual ſtimulus; the irritability of their fibres accumulates in conſequence of their obſtruction, the return of the heat again exhauſts the fibre. The more intenſe the cold is, the greater is the accumulation of irritability. After the fibre has been expoſed for ſome time to a great degree of cold, its irritability is encreaſed to ſuch a degree, that the moſt trifling degree of heat produces the moſt violent effects: hence the glow experienced after coming out of a cold bath; hence

the diſeaſes which are caught in coming out o the cold air into a warm room, and which medical men attribute to checked preſpiration, a ſuppoſition entirely falſe.

" The leaſt movement is attended with fatigue upon the ſummit of high mountains, as I have frequently experienced, but eſpecially in 1785, upon the top of the *Buet*, and as M. Sauſſure has likewiſe obſerved, upon the ſummit of *Mount Blanc**. The reaſon of it is this, the fibre is

* " Les forces muſculaires s 'epuiſent avec une extrême " promtitude.---Ce qui diſtingue & caracteriſe le genre de fa- " tigue que l'on eprouve á ces grandes hauteurs, c'eſt un " epuiſement total, une impuiſſance abſolue de continuer ſa " marche---On ne feroit pas á la lettre quatre pas de plus, " fût-ce pour eviter le danger le plus eminent.—Si l'on per- " ſiſte a faire des efforts, on eſt ſaiſi par des palpitations & " par des battemens ſi rapides & ſi forts, dans toutes les arte- " res, qui l'on tomberoit en defaillance ; ſi on l'augmentoit " encore in continuant de monter.

" La ſeule ceſſation de monvement, dans trois ou quatre ren-

rendered ſo irritable by the cold of thoſe Mountains, that the leaſt motion of the muſcles, or what is the ſame thing, the leaſt action of the nervous ſtimuli, exhauſts it. It is by the gradual application only of heat that frozen limbs can be recovered, and it is neceſſary always to begin by rubbing them with ſnow; without this the fibre will be exhauſted, and become gangrenous.

"minutes, ſemble reſtaurer ſi parfaitement les forces, qu'en "ſe remettant en marche, on eſt perſuadé qu'on montera "tout d'une haleine juſques à la cime de la montange. Or dans "la plaine une fatigue auſſi grande ne ſe diſſipe point avec "une telle facilité. Mr Pictet ſe trouve toujours ſaiſi d'une eſ- "pece d'angoiſſe, d'un leger mal de cœur, & d'un degout "abſolu, deſqu 'il eſt arrivé a la hauteur d'environ 1400 "toiſes au deſſus de la mer." (Vide Sauſſure Voyages, 4to. I. 482, &c.)

Mr. Sauſſure likewiſe tells us that on the Col de Géant, at 1763 toiſes above the level of the ſea, "Le charbon ne brû- "loit que d'une maniere languiſſante, & a force d'être "animé par le ſoufflet." (*Journ. de Phys.* Sept. 2788, p. 209.

"During

" During the winter, by the abſence of the ſtimulus of heat, and in part of light, plants and many animals become torpid, the organs of circulation and of nutrition perform their functions but languidly, and life itſelf appears ſuſpended. In conſequence of the diminiſhed action of theſe ſtimuli, the irritability accumulates, and manifeſts itſelf at the return of ſpring. The leaſt degree of heat then produces the moſt violent effects upon the fibres thus delicately irritable.

" Animals, which had concealed themſelves under ground, venture forth from their ſubterraneous retreats, plants put forth their leaves and flowers, and man himſelf is ſenſible of the ſtimulus of heat in the gales of ſpring; his fibre being rendered more irritable by the winter's cold. Vegetation is much more vigorous in ſpring-time than during the reſt of the year. It diminiſhes during ſummer in proportion as the irritability accumulated during winter is diminiſhed by the action

action of heat and light, and laſtly, is exhauſted in the autumn.

"Dr. Hales obſerves, that the rapidity with which the ſap circulates in the vine during ſpring is five times greater than the rapidity with which the blood flows in the arteries of a horſe.

"This motion is much ſlower in ſummer, and almoſt ceaſes in autumn. It is not the effect of the heat alone, for if that were the caſe it would increaſe as the heat increaſed, and the effect would be proportionate to the cauſe; it is the effect of the irritability accumulated in conſequence of the abſence of heat during the winter. The effects of winter are very great in cold climates, becauſe the accumulation of the irritability is in proportion to the abſtraction of the ſtimulus of heat. In Lapland corn ripens in ſixty days, whereas in France it requires an hundred and twenty or an hundred and thirty days.

"The

" The truth of what I have advanced may be proved by expoſing vegetables alternately to heat and cold: it is ſurpriſing how much their growth and the power of vegetation is increaſed. But in theſe experiments care muſt be taken to vary the temperature by degrees; becauſe the irritability accumulating in the fibre by the abſtraction of heat, a very ſmall quantity of this ſtimulus then applied is ſufficient to exhauſt it entirely, or to deſtroy it. Hence it is that the return of cold and froſt in the beginning of ſpring is ſo noxious to vegetables, and that the year is in general more abundant after a very cold winter.

" Mr. Fontana obſerved, that during the winter the vipers which he kept for his experiments were in a torpid ſtate, though the thermometer was at 59°. He endeavoured to render them vigorous by warmth and expoſed them to a heat of 67° only. In two minutes they died, though during ſummer they bore a much greater degree of heat; but then they are leſs irritable. *Spallanzini* obſerved

obſerved that *newts* bury themſelves in the earth and become torpid in the month of October, before the thermometer in the ſhade falls to 54°½, and that they re-appear in the month of February, though at that time it freezes every night, and frequently during the day, and the thermometer is many degrees below 54°. What is the reaſon, enquires this excellent obſerver, that theſe animals revive in ſpring, when the cold is more intenſe, and ſink into torpidity at a much leſs degree of cold in autumn? I will ſolve this problem by obſerving that in autumn a very great ſtimulus is required to act upon the fibre of theſe animals, exhauſted as it has been by the heat of the ſummer; but in ſpring, the leaſt ſtimulus, the leaſt increaſe of heat is ſufficient to put the fibre in action, its irritability having accumulated during winter, in conſequence of the abſence of the common ſtimuli.

" *Light* is another common ſtimulus. To convince myſelf of the ſtimulating quality of light upon

upon plants by direct experiments, I enveloped the leaves of some plants in an opaque body, so that the air might have free access, while the light could not penetrate. I found that these leaves became more irritable than the others, the irritability having accumulated. By the abstraction of the stimulus of light, the irritability of organized bodies accumulates, and a disease ensues, which is called *etoilement*. Animals deprived of light, and living in dark places, lose their colour, and become white, as observed in arctic animals during the long nights in the countries near the pole: I have observed it also in animals that inhabit the Alps, and which conceal themselves for the greatest part of the year in subterraneous dwellings. *Blanched* plants lose their green colour and become whitish and sickly. Some poisonous plants lose their noxious qualities and become agreeable to the taste, merely by the abstraction of the stimulus of light. White animals and plants are very irritable; and it is observed that these

animals

animals and plants are not capable of ſupporting a great quantity of light.

" The action of the light upon plants has been very well obſerved by Dr. Ingenhouſz and Mr. Senebier, and the manner in which colours are produced has been explained by M. De la Metherie. It is well known that animals that have been tamed, and eſpecially domeſtic animals, change their colour by education; but an obſervation that has perhaps eſcaped naturaliſts is, that this change is conſtantly from dull colours to thoſe that are brighter or leſs dull. I have often obſerved that the change takes place more frequently in dark than in light places. Mice kept in a cage in a dark room have produced white mice."

" The third common ſtimulus *is that of nutriment*. It requires a very ſmall quantity to ſupply the daily loſſes; the greateſt portion is employed in depriving the ſtomach, and of courſe the whole ſyſtem, of its ſuperfluous irritability. This is

proved by what is obſerved in organized bodies. All animals are more irritable before than after food. Hunger, of which appetite is the leaſt degree, is cauſed by the accumulated irritability of the ſyſtem."

" The *gaſtric juice* acts upon the fibres of the ſtomach become more irritable, and produces the ſenſation of hunger. Spallanzani has obſerved that birds of prey do not void indigeſtible bodies, ſuch as pieces of glaſs or metal, which they have taken in with their food, before their ſtomach is empty.

" Theſe indigeſtible bodies cannot be voided while the ſtimulus of the nutriment acts upon the ſtomach; but as the abſtraction of this ſtimulus gives the irritability of the ſtomach an opportunity of accumulating, the indigeſtible bodies very ſtrongly ſtimulate the fibres of the ſtomach, make them contract, and by this contraction they are voided. It is poſſible to do almoſt wholly without

out nutriment, by applying, from time to time, ſome other ſtimulus to the ſtomach, ſuch as tea, coffee, alcohol, opium, and by theſe means exhauſting the accumulated irritability of that organ.

" By the entire abſtraction of the ſtimulus of nutriment, the irritability of the ſyſtem is prodigiouſly increaſed. There are many inſtances of perſons, who, not having eaten any thing for many days, have been intoxicated and killed in conſequence of ſwallowing with greedineſs, two or three cups of broth.

" Plants ſuddenly tranſplanted from a meagre, into a rich ſoil, produce no fruits or ſeeds, and die in a ſhort time of a particular diſeaſe, cauſed by exceſs of nutriment.

" The *circulation of the fluids* is the moſt powerful of the common ſtimuli. The blood which oxygenates itſelf during its paſſage through the lungs

lungs, parts with its oxygene in the circulation, the oxygene having a ſtronger attraction for the irritable fibre than for the carbon which is contained in the blood.

" In this operation the heat combined with the oxygene is ſet free, hence animal and vegetable heat. The blood acts continually upon the irritable fibre, and the fibre re-acts upon the blood, and this action and re-action are ſtronger in proportion as the circulation is more rapid, and as the air which comes in contact with the blood in the lungs contains more oxygene air.

" When any local ſtimulus continues to act upon any part of the ſyſtem, the circulation becomes more rapid, and a fever is the conſequence.

" Is the ſtimulus weak, a ſlow fever enſues, which will by little and little exhauſt the irritability of the ſyſtem, and the patient will die of a con-

conſumption. Is the ſtimulus ſtronger, or the fibre upon which it acts more irritable, we ſhall have an ardent fever, which will exhauſt the irritability in a leſs time.

" In fine, is the ſtimulus very violent, or the fibre diſeaſed by an exceſs of irritability, we ſhall have a putrid fever, which will deſtroy the patient, whether animal or vegetable, and will exhauſt the irritability in a very ſhort time.

" But whatever be the nature of the fever, the fibre irritated by the ſtimulus will act upon the blood more than ordinarily, the re-action of the blood will be increaſed in proportion, the circulation will be more rapid, the blood will abſorb more oxygene, and the whole ſyſtem will be ſurcharged.

" By this means the irritability will be increaſed, the animal heat augmented, and the effect of the action of the ſtimulus becoming greater, in

proportion

proportion to the accumulation of irritability, a total exhauſtion of the irritability, or the death of the patient, will enſue.

" There are two methods of prevenring the fatal effects of a local ſtimulus, whoſe operation upon one part of the ſyſtem is conſtant. The firſt conſiſts in preventing the ſurcharge of oxygene in the blood, which is accompliſhed by diminiſhing the proportion of oxygene gaz in the air breathed by the patient, or by diminiſhing the quantity of blood by phlebotomy. The ſecond method conſiſts in applying ſtimuli capable of exhauſting the irritability in proportion as it accumulates; ſuch as wine, opium, bark, heat, &c. Phlebotomy acts by diminiſhing the quantity of blood, and conſequently its operation is attended with this effect, viz. of diminiſhing the re-action, and reſtoring to the fibre its tone.

" I ſhall here obſerve by the way, that the advice which many phyſicians have given, to make

the

the patient breathe oxygene gaz, is the moſt pernicious they can give; for the patient always finds himſelf worſe after having breathed this oxygene gaz, as I have frequently had occaſion to obſerve."

" The *nervous ſtimulus* is the only one which is peculiar to animals. It is this ſtimulus which is the cauſe of the voluntary motions, of convulſions, and paſſions. The paſſions differ from one another only in ſtimulating the irritable fibre more or leſs. Anger and joy are very powerful degrees of the nervous ſtimulus; content and hope are weak degrees; fear, ſorrow, fright, deſpair, are not abſolute degrees of this ſtimulus, they are only the abſtraction of the ſtimuli of hope, content and happineſs.

" Anger and joy act as very powerful ſtimuli and exhauſt the irritability of the fibre in the ſame manner as any other ſtimulus whatever. Content and

and hope are degrees of the nervous ſtimulus, neceſſary to preſerve the tone of the fibre.

" Sorrow and fright are degrees too weak. If they continue to act, the irritability of the fibre accumulates. It is well known that fearful and melancholy perſons are oftener affected by the ſtimulus of contagious diſeaſes than they who are free from fear, and who take the precaution of applying a greater quantity of ſtimulus than ordinary to their fibres, by taking wine, vinegar, opium and bark.

" According to the obſervations of Mr. Fontana, timid and fearful animals die much ſooner of the bite of the viper than courageous or irritated animals.

" Joy, excited by the annunciation of good news, to a ſorrowful perſon, and one of courſe very irrible, has often cauſed death. The ſtory of the Roman Mother is well known, who was bewailing the death

death of her ſon, and who dropped down dead for joy, the moment ſhe ſaw him enter her room alive.

"By the abſtraction of many of the common ſtimuli for any length of time, the irritability of the fibres accumulates ſo much, that the moſt trifling ſtimulus produces the moſt violent effects, and frequently even inſtantaneous death.

"This diſeaſe is called the ſcurvy, concerning the nature of which medical men have formed ſo many falſe and ridiculous theories. It is of the utmoſt importance to mankind to know the true nature of this diſeaſe; ſince, in conſequence of our ignorance in this particular, we have been unable to find a ſure remedy for it, and ſo many thouſands of lives have fallen a ſacrifice to its ravages, in armies, fleets, and beſieged towns.

"In the laſt war, the Engliſh fleet ſuffered dreadfully from the ſcurvy; and laſt year many

ſoldiers died of this diſeaſe in the imperial city in Walachia, in conſequence of the abſtraction of the ſtimulus of nutriment, (the Emperor having ordered that a kind of paſte, made of bread and water ſhould be given to the ſoldiers inſtead of meat) of the ſtimulus of oxygene, in the corrupted atmoſphere of the fens of Walachia, and laſtly of the nervous ſtimulus, the moſt powerful of all; for the greateſt part of the army were engaged by force and againſt their inclinations.

"The abſtraction of all theſe ſtimuli accumulated the irritability of the fibre, and cauſed the ſcurvy, and that dreadful mortality that took place in the army. The ſame cauſes produce the ſame effects on other animals. We ſee domeſtic animals affected with the ſcurvy in conſequence of cold and hunger, that is to ſay, in conſequence of the abſtraction of the ſtimuli of heat and nutriment.

"The ſheep which Captain Cook had on board his ſhip, on his voyage round the world, in the

the years 1772, 3 and 4, died of the ſcurvy, their teeth fell out, their gums rotted; in a word, they had all the ſymptoms of an inveterate ſcurvy. The abſtraction of the common ſtimuli in plants produced ſimilar ſymptoms and a ſimilar diſeaſe.

" The diſeaſe of Rye called *ergot* is exactly analogous to the ſcurvy in animals* ; the *ergot* is the ſcurvy of plants; it is the effect of accumulated irritability in the fibres of plants. The cauſes which produce the ſcurvy in animals, according to the obſervations of *Saillant* and *Teſſier*, are, a wet and barren ſoil, and a cold ſummer ; that is to ſay, the cauſes of the *ergot* are, the abſtraction of the ſtimuli, of nutriment and heat.

* See Dr. Trotter's very valuable Treatiſe on this diſeaſe, Edit. 1792---Beddoes' Obſervations, &c. where not only all the ſymptoms, cauſes and effects of this diſeaſe are fully explained, but alſo an almoſt infallible remedy is pointed out; known to modern chemiſts under the denomination of the *citric acid*.

" I could enlarge upon this intereſting ſubject, if I were not afraid of making this eſſay too long. I wiſhed to give only the outlines, or a general view of my theory, without entering into the detail. In the ſubſequent eſſays I ſhall treat of oxygene conſidered as the principle of irritability, or the compoſition or decompoſition of water in animals and plants, of the different kinds of air contained in the interior cavities of organized bodies, and of the circulation of this air, the exiſtence of which has not hitherto been even ſuppoſed, although, as I ſhall prove hereafter, the lymphatics in animals, and the fibres in plants, are almoſt ſolely deſtined for the circulation of theſe elaſtic fluids ! ! ! "

Such are the general outlines of a new ſyſtem of phyſiology founded by the ingenious Dr. Girtanner, and from which we may at leaſt derive many very important facts.

Having endeavoured to prove that the principle of life was dependent on irritability, or rather

that

that irritabily is itſelf the principle of life; he proceeds to examine the principle of irritability, and to prove that oxygene is itſelf that principle; which is conveyed to the blood in the lungs by the function of reſpiration and thence diſtributed to every part of the ſyſtem in the courſe of circulation; combining with ſtimulating ſtubſtances, which come in contact with different parts of the ſyſtem.

He is decidedly of opinion that *oxygene* is abſorbed by the blood, and that the *venous blood*, is oxygenated in the lungs during reſpiration; whereas the moſt celebrated naturaliſts, phyſiologiſts and chemiſts are of a directly oppoſite opinion, ſuppoſing that oxygene does not combine with the venous blood; but that the latter loſes *carbon* and *hydrogene* recovering the florid colours natural to it, without the aſſiſtance of any principle abſorbed from the atmoſphere, and from the following experiments have they drawn their concluſions.

Firſt, by expoſure to hydrogene air *arterial blood*, becomes

becomes deprived of its vermilion colour, assuming the black and darker hue of *venous* blood; while a part of the hydrogene air becomes absorbed.

Secondly, Mr. Hamilton made three ligatures on the jugular vein of a cat; and having expelled the blood from between two of the ligatures, he introduced the hydrogene air and kept it there, closing the aperture through which it had been introduced. He then loosened the middle ligature, and the blood contained between that and the third ligature came in contact with the *hydrogene air*, and about an hour afterwards, having taken the blood from the vein, he found it liquid, and of a dark colour, nearly approaching to that of ink.

Thirdly, *Venous blood* by exposure to *vital air*, acquires the bright vermilion colour of *arterial blood*, rendering the air impure.

The

The following concluſions have been drawn from theſe experiments by Mr. Lavoiſier and Dr. Crawford*.

Firſt, That the change of colour, which the blood undergoes, during the courſe of circulation, is produced from its combination with *hydrogene air*.

Secondly, That in its paſſage through the lungs, the blood gives out a portion of the hydrogene it contains, and then reſumes its vermilion colour.

The above mentioned authors ſuppoſe that during reſpiration the vital air which is received into the lungs, combines with carbon and hydrogene diſengaged from the blood; forming *carbonic air* with carbon, and with hydrogene *water*, while the blood, having loſt the carbon and hydrogene

* Vide Annales de Chimie, tom. 5. p. 267—Crawford on Animal Heat.

with

with which it had been charged during its circulation, again recovers its vermilion colour.

We may however, without detracting from the merit of thoſe highly diſtinguiſhed philoſophers, very readily infer, that theſe concluſions do not *neceſſarily* reſult from thoſe experiments, and we now very certainly know that they are to be explained in a manner more conformable to the laws eſtabliſhed by modern chemiſtry.

We know of no experiment which might authorize us to ſuppoſe that carbon can unite with oxygene in a temperature of 97°—99°, or that hydrogene and oxygene airs combine and form water in ſo low a temperature.

M. Seguin has attempted to anſwer this objection, by ſuppoſing that the carbon is in a very attenuated ſtate in the blood, and by citing the experiments of Mr. Bertholet upon hydrogene air.

But

But this explanation appears hypothetical, and no way convincing.

Having for a conſiderable length of time paid very particular attention to the phenomena of reſpiration, and after having made numerous experiments upon this ſubject: Dr. Girtanner concludes, that during reſpiration one part of the oxygene of vital air combines with the *venous blood*, changing its black colour to that of a bright vermilion; and which the ingenious Dr. Goodwin has long ſince proved*; the ſecond part of this oxygene unites with the carbon contained in the carbonic-hydrogene gaz, which exhales from the venous blood, and forms carbonic acid air; a third part is combined with the carbon of the mucus, which the lungs contain in great quantities, and which is in a continual ſtate of decompoſition; forming alſo carbonic acid air; and a fourth part of this

* Vide Goodwin's Connection of Life with Reſpiration p. 61.

oxygene combines with the hydrogene of the blood to form water, which is exhaled during refpiration.

That portion of heat which was contained in the vital air previous to its decompofition, now remains united in part with the oxygene and the blood.

Hence the peculiar difference of heat in *arterial* and *venous* blood.

Another portion of heat enters into combination with the carbonic acid air, and a third part produces a temperature neceffary for the formation of water, by the combination of the hydrogene and oxygene airs.

Hence the effects of refpiration will of courfe be thefe.

Firft,

Firſt, That the venous blood becomes deprived of the carbonic hydrogene air which it contains, and abſorbs oxygene air, which gives riſe to its vermilion colour, which it likewiſe imparts to metallic oxids, nitrous acids, and ſeveral other ſubſtances with which it enters into combination.

Secondly, As oxygene increaſes the capacity of all ſubſtances with which it unites, ſo will the capacity of the blood be encreaſed.

Thirdly, The oxygene air of the atmoſphere is in part abſorbed by the venous blood, partly changed into carbonic acid air by the carbon of the blood and the mucus of the lungs, while the remainder in combination with the hydrogene air forms water, and a quantity of heat is ſet at liberty. Conſequently the products of reſpiration will be—

1. Animal oxid, fluid (i. e. arterial blood.)
2. Carbonic acid air.
3. Water.
4. A ſmall quantity of liberated heat.

From

From this theory it cannot be difficult to explain the experiments we have cited.

If we expoſe arterial blood to the contact of hydrogene air, the quantity of air will be diminiſhed, loſe its vermilion colour, and become livid.

In this experiment the exact reverſe takes place of what is obſervable in reſpiration. The hydrogene air combines with the oxygene air of the blood to form water, while the *arterial blood* thus deprived of its oxygene becomes black, and having the appearance of venous blood; aſſuming a deep colour only from the want of oxygene.

Mr. Hamilton's experiment proves this, he alſo adds that he found the blood liquid and very little coagulable. The Doctor obſerves in his firſt eſſay, that the coagulability of fluids obeys the ſame laws, and depends upon the ſame principle as the irritability of the fluids, conſequently the blood deprived of the irritable principle, or of oxy-

oxygene, ought to be liquid, that is, to poſſeſs little or no coagulability.

The third experiment is a direct and convincing proof that the florid colour of *arterial blood* is owing to the abſorption of oxygene in its paſſage through the lungs.

Having ſhewn the futility of thoſe arguments on which the more generally received theory of reſpiration is founded, he proceeds to the ſtatement of ſome experiments in favour of his new theory.

Experiments upon venous blood.

Firſt, Six ounces of black venous blood, taken from the jugular vein of a ſheep, were introduced into a veſſel filled with oxygene air, and in an inſtant the blood aſſumed a vermilion colour; the thermometer within the veſſel roſe ſeveral degrees, but ſunk again immediately. The mercury in which

which the veſſel was placed roſe from ſix to eight lines.

When the experiment was finiſhed, the blood was encreaſed a little in weight; but though I am certain of this encreaſe of weight from repeated experiments, I cannot exactly aſcertain this encreaſe, as the inſtruments I made uſe of for this purpoſe were not ſufficiently accurate for ſo delicate an experiment.

The oxygene air which the veſſel contained was mixed with carbonic acid air, which lime water abſorbed. Some drops of water were formed at the bottom of the veſſel.

This experiment ſeems obviouſly to prove that carbonic acid air and water, are formed during reſpiration, or rather that the baſe of hydrogene air is exhaled from the blood.

Secondly, The jugular vein of a ſheep was opened

ed and the blood which flowed from it was received in a glaſs bottle filled with oxygene air, and the bottle when half full was cloſed. The blood which it contained immediately aſſumed a vermilion colour, became very fluid and coagulated but ſlowly, into a reddiſh and thick maſs, without any ſeparation of ſerum. The next day on opening the bottle, in order to examine the air which it contained, the oxygene air was found mixed with carbonic acid air. Some drops of water were formed near the mouth of the bottle. This experiment confirms the firſt.

Thirdly, A conſiderable quantity of very pure oxygene air was injected into the jugular vein of a dog; when the animal raiſed the moſt terrible outcries, breathing very quickly, and with the moſt extreme difficulty; his limbs became gradually ſtiff and hard, he fell aſleep and died in leſs than three minutes.

Upon opening the thorax and pericardium, the

the heart was found more irritable than ordinary, and its alternate contractions and dilatations continued upwards of an hour.

The right auricle of the heart was of a florid red colour and it contained, as alſo did the right ventricle, a conſiderable quantity of blood of a bright vermilion colour, frothy, and not coagulated.

The blood contained in the left ventricle, in the aorta, and the arteries, was of a roſe colour, and mixed with bubbles of air. All the muſcles were more irritable than ordinary; but after the blood contained in the heart and veins was diſcharged, the irritability of the heart and muſcles ſenſibly diminiſhed.

This experiment appears to me a moſt deciſive proof that the florid colour which the blood aſſumes in paſſing through the lungs, does not ariſe from its being deprived of the carbonic hydrogene air,

air, but that it proceeds from the combination of oxygene air with the blood.

In the experiments we have juſt cited, the livid colour of the venous blood in the right auricle and right ventricle of the heart was changed to a more florid red colour. Yet it could not have loſt any carbonic hydrogene air ; but only acquired oxygene.

This experiment ſeems alſo to prove that oxygene is the principle of irritability ; for by ſurcharging the blood with oxygene, the irritability of the blood was, as we have ſeen, conſiderably increaſed.

Fourthly, A ſmall quantity of azotic air, which had been expoſed for ſome time to the contact of lime water in order to ſeparate from it any carbonic acid air it might contain, was injected into the jugular vein of a dog ; and the animal died in thirty ſeconds.

Upon opening the thorax, the pericardium, and heart, the right auricle and ventricle were filled with black, thick, and coagulated blood. The left ventricle was of its ordinary colour. The heart and nearly all the muſcles loſt their irritability almoſt entirely; contracting but feebly upon the application of the ſtrongeſt ſtimuli, ſuch as ſulphuric æther, and the electric ſpark.

5. The venous blood of a ſheep was received in a bottle filled with azotic air; and the blood conſtantly coagulated, aſſuming a colour black as ink, with the ſeparation of a very conſiderable quantity of ſerum.

The next day on opening the bottle a faint ſmell of ammoniac was perceiveable; and the air was azotic air, incapable of ſupporting flame.

In this experiment the colour of the venous blood was rendered darker and even quite black, by expoſure to azotic air.

The

The ammoniac produced was owing to the hydrogene air which had eſcaped from the venous blood entering into combination with the azote.

Hence, the colour of the blood becoming deeper, after having loſt part of the hydrogene with which it had been charged, would ſeem to prove that this deepneſs of colour aroſe from the preſence of carbon in the blood, and not, as has been ſuppoſed, from its combination with hydrogene air.

6. A bottle full of carbonic acid air was half filled with the venous blood of a ſheep. It coagulated in an inſtant, aſſuming a very dark colour; and likewiſe affording by ſpontaneous ſeparation a very conſiderable quantity of a reddiſh-coloured ſerum.

7. Having injected a ſmall quantity of carbonic acid gaz into the jugular vein of a dog; the animal inſt became ſleepy, and died in the courſe of fifteen minutes.

The

The right auricle and ventricle were found filled with a thick blood, partly coagulated. The blood in the left auricle and ventricle, was of a more deep colour than ordinary; and the heart and muſcles had loſt all their irritability.

This experiment alſo proves that the dark colour of the venous blood is not owing to the combination of hydrogene air.

Perhaps in this experiment, part of the oxygene of the corbonic acid air unites with the hydrogene of the blood, and forms water, and the carbon which was before combined with the oxygene, unites with the blood, and gives it a deeper colour.

8. Blood drawn from the jugular vein of a ſheep was received in a bottle full of nitrous air, and when the bottle was half filled it was cloſed. The blood immediately took a concrete form, ſeparating

parating a very conſiderable quantity of a black-iſh ſerum.

The day following, on opening the bottle, a very ſtrong ſmell of nitrous æther was perceived; the nitrous air having been changed in part to nitrous æther by the carbonic-hydrogene air of venous blood.

This experiment would ſeem to prove beyond a doubt that venous blood contains carbonic-hydrogene air, and that this air is not very intimately combined therewith, ſince it is not ſo eaſily ſeparated from it.

The nitrous æther produced in this experiment ariſes from the combination of the carbonic-hydrogene air. The blood after having loſt this air, does not aſſume its vermilion colour; but on the contrary becomes ſtill deeper; it is not therefore, to the union of the blood with carbonic-hydrogene, that the peculiar deep colour of

venous

venous blood is owing, ſince this colour becomes ſtill deeper, on the ſeparation of hydrogene from the blood.

9. Having injected a ſmall quantity of nitrous air into the jugular vein of a dog; the animal died in leſs than ſix minutes.

The right auricle and ventricle of the heart on examination were found filled with thick, black, and partly coagulated blood. The blood contained in the left ventricle of the heart, was of a much deeper colour than ordinary; and the heart had loſt its irritability. The lungs were of a greeniſh caſt, and perfectly putrefied*. All the canal of the wind pipe was filled with green foam, which iſſued in great quantities from the mouth

* Dr. Beddoes remarks, and we would think, very juſtly, that theſe appearances were only a ſign of the preſence of nitrous acid, and not of putrefaction—p. 227.

of

of the animal during the convulſions which preceded its death.

Experiments upon arterial blood.

10. An inciſion was made into the carotid artery of a ſheep, and the blood that iſſued thence was received into a bottle full of oxygene air; and the bottle, when half filled was cloſed.

The colour of the blood became in an inſtant of a bright vermilion. The next day the bottle was opened, and the oxygene gaz which it contained was foud mixed with a very ſmall quantity of carbonic acid gaz.

11. The arterial blood from the carotid artery of a ſheep was received into a bottle full of azotic air, and the bottle, when half filled, was cloſed. The blood coagulated at the ſame moment and aſſumed a very deep colour.

On opening the bottle the next day, the azotic air

air which it contained was found mixed with a ſmall quantity of oxygene air; rendering it capable of ſupporting flame for about two minutes.

This experiment would ſeem to prove deciſively and beyond any poſſibility of doubt. Firſt, that arterial blood contains oxygene air, and ſecondly, that its vermilion colour is produced by its combination with this air; which colour it again loſes on being deprived of its oxygene air.

Hence ariſes our conviction, of the vaſt importance of circulation, and from this theory it may be no very difficult task to explain almoſt every phenomena of the animal œconomy.

12. Three ounces of vermilion coloured blood, taken from the carotid artery of a ſheep, were received upon a plate, which was immediately placed under a veſſel filled with carbonic acid air. The blood did not ſuffer any alteration of colour, but continued the ſame for ſome hours.

13.

13. Arterial blood, drawn from the carotid artery of a ſheep, was received into a bottle filled with carbonic acid air; but no change of colour took place.

Theſe two laſt experiments ſeem to prove that carbonic acid air, has little or no action upon arterial; while its influence on the venous blood is very conſiderable.

14. Arterial blood, taken from the carotid artery of a ſheep was received into a bottle full of nitrous air, and the bottle when half filled was cloſed. The blood contained in it coagulated immediately, aſſuming a green colour upon the ſurface, and at the ſame time ſeparating a ſmall quantity of a greeniſh ſerum.

The day after, on opening the bottle, the vapours of nitrous acid were obſerved by all who were preſent. This experiment ſeems to prove, in a ſtill more deciſive manner than any of the

former, the preſence of oxygene in the arterial blood ; ſince it is from this alone it is capable of changing *nitrous air* into *nitrous acid.*

The green colour, obſerved in this, as alſo in the ninth experiment, is owing to a ſeparation of part of the azote from the nitrous air.

15. Arterial blood, drawn from the carotid artery of a ſheep, was received into a bottle full of hydrogene air, which when half filled was cloſed. The blood became of a much brighter vermilion, and remained fluid for ſome time. It however at laſt took a concrete form, and a ſmall quantity of ſerum was ſeparated.

On the following day, the hydrogene air contained in the bottle was found mixed with a ſmall quantity of oxygene air, which the nitrous air abſorbed. This experiment alſo proves the preſence of oxygene air in arterial blood.

16.

16. Arterial blood, was received in a bottle containing equal portions of oxygene and hydrogene air, and the bottle when half filled was closed. The blood in the bottle became moderately hot, remained fluid, and was of a more bright vermilion colour. It at length coagulated, and a small quantity of serum was separated.

On examination the day after, the air in the bottle was found mixed with a small quantity of carbonic acid air, the presence of which was ascertained by lime water.

17. A small glass tube was filled with arterial blood of a bright vermilion colour; it was sealed hermetically and exposed to the light. The blood gradually changed colour, and in six days became as black as venous blood.

18. The same experiment was repeated, only with this difference, that the tube was exposed to the influence of heat instead of light, but without

out

out any other difference in the result, than that of the same effect being produced in a much shorter time.

The 17th and 18th experiments made by Dr. Priestly, and afterwards repeated, seem to demonstrate, that it is not from the contact with hydrogene air that the venous is of a more deep colour than that of the arterial blood.

From these experiments he concludes—

1. That the change of colour the blood undergoes during circulation is not owing to its combinations with hydrogene air.

2. That the deep colour of the venous blood is owing to the carbon it contains.

3. That the vermilion colour of the arterial blood proceeds from the oxygene with which the blood is combined, during its passage through the lungs.

4. That reſpiration is a proceſs exactly analogous to the combuſtion and oxidation of metals; that theſe phenomena are the ſame, and to be explained in the ſame manner.

5. That during circulation, the blood loſes its oxygene, and charges itſelf with carbonic-hydrogene air, by means of a double affinity.

6. That during the diſtribution of the oxygene through the ſyſtem, the heat which was united with this oxygene eſcapes; hence the phenomena of animal heat, &c.

7. That the great capacity of the arterial blood for heat is owing to the oxygene with which it is united in the lungs.

Having pretty clearly demonſtrated that the blood is oxygenated in its paſſage through the lungs; that in the courſe of circulation it becomes deprived of the oxygene which it had abſorbed from

from the atmoſphere ; and that it returns to the lungs ſurcharged with carbonic-hydrogene air, it now remains to prove that this oxygene gives riſe to irritability, and the life of organized bodies.—And the following are proofs on which he founds this theory.

The irritability of all organized bodies is in a direct ratio of the quantity of oxygene they contain.

1. Whatever increaſes the quantity of oxygene in organized bodies, at the ſame time increaſes their irritability.

In the third experiment above cited we have ſeen a direct proof of this, and other phenomena ſeem obviouſly to favour his opinion. Animals made to breath oxygene air have their irritability very conſiderably encreaſed. Blanched plants, whoſe irritability has been accumulated in conſequence of the abſtraction of light, contain (according

cording to the experiments of Mr. Fourcroy) a very conſiderable quantity of oxygene.

Dr. Girtanner obſerved, that in the courſe of his experiments, plants made to grow in oxygene air, became white, although expoſed to the influence of the light.

But what ſeem more forcible proofs of irritability being always in proportion to the quantity of oxygene, are the phenomena attendant on the action of mercury and mercurial ſalts upon animals.

This being one of the moſt ſtriking proofs of his theory it may not be unworthy of our taking notice of it at ſome length.

It is a fact, he obſerves well known by phyſicians, that mercury, in its metallic ſtate, has no effect upon the human body; many people have been known to take a daily portion of quickſilver,

ver, to the amount of two or three ounces, for years, from the idea of its guarding them againſt epidemic diſeaſes, but who could never perceive any ſenſible effect whatever from ſo ſingular a cuſtom.

The experiments of Dr. Saunders alſo prove, that the effects of mercurial ointment are owing only to the ſmall quantity of mercury that has been oxidated in the courſe of a long trituration. Hence we would conclude, that it is neceſſary mercury ſhould be oxidated, in order to have any effect upon the human body.

On the other hand, it is well known that in perſons who have rubbed themſelves with mercurial ointment, or who have taken the oxid of mercury internally, the mercury, after having produced its uſual effects upon the ſyſtem, has paſſed through the pores of the skin in a metallic form, and has amalgamated itſelf with watches, gold in the pocket, &c.

The

The oxid of mercury, in paſſing through the human body becomes deprived of its oxygene, and to this oxygene alone, which remains combined with the ſyſtem, are owing the effects produced by oxidated mercury.

Theſe effects he calls the mercurial diſeaſe, the ſymptoms of which are nearly the ſame as thoſe of ſcurvy; the mouth, gums, and whole ſyſtem becoming affected in a manner extremely analogous.

But the ſcurvy he obſerves, is a diſeaſe produced by the accumulation of the irritable principle*. The accumulation therefore of the oxygene producing the ſame effects, the ſtriking analogy between the irritable principle and oxy-

* The Doctor's opinion in this inſtance is certainly very erroneous, ſince it is, I believe, from the *want* of oxygene (which he conſiders the principle of irritability) that this diſeaſe takes its riſe.

gene appears to be proved ; and from hence he concludes, that oxygene is the principle of irritability†.

2. Every thing that diminiſhes the quantity of oxygene in organized bodies, at the ſame time diminiſhes their irritability.

This was clearly demonſtrated in the 9th experiment where the heart and muſcles loſt their irritability, on being deprived of their oxygene by nitrous acid. But to put this beyond a doubt he inſtituted the following experiment.

Exp. 19. The heart of an animal juſt killed was cut into pieces, and put into a glaſs retort, to which was affixed a pneumatic apparatus. A very ſmall degree of heat was applied to it, by means of a lamp placed under the retort. When

† M. Bertholet, in the Paris Memoirs, for the year 1788, has attributed the cauſticity of metallic oxids to the hydrogene they contain.

the

the pieces were heated, bubbles of air were perceived in the pneumatic apparatus. They remained expoſed to the ſame degree of heat for nearly two hours, till the ſurface was juſt burnt.

Upon examining the air which had paſſed into the apparatus, it was found that the firſt portion of air was the atmoſpheric air of the retort, mixed with a very ſmall quantity of vital or oxygene air, the preſence of which was aſcertained by nitrous air; the ſecond was vital air mixed with carbonic acid air.

He repeated this experiment upon various other parts of animals recently killed, always obtaining a greater or leſs quantity of oxygene air.

The ſame quantity of this air, he obſerves, may be obtained, for many ſucceſſive times, by expoſure of the animal ſubſtance, alternately to atmoſpheric air and a heat equal to 60° or 70° of Reaumur's ſcale. He remarks that theſe experiments are very difficult, and require ſome time

to

to aſcertain the degree of heat neceſſary to diſengage the oxygene air, for if the degree of heat applied be too great, inſtead of oxygene air, carbonic acid air will be forced over.

From the foregoing obſervations it may be collected, that oxygene combines with the venous blood in the lungs; that it is diſtributed to every part of the ſyſtem in the courſe of circulation, and that to this principle irritability is owing; it remains only to examine what becomes of the vaſt quantity of oxygene, which all parts of the ſyſtem are continually receiving from the blood.

In his firſt memoir he has obſerved that there are three different ſtates of the organized fibre.

1. The ſtate of health or tone of the fibre.

2. The ſtate of accumulation, in which the fibre has become ſurcharged with the irritable principle.

3. The

3. The ſtate of exhauſtion, in which the fibre fails through want of the irritable principle.

Every ſubſtance capable of coming in contact with the irritable fibre, may likewiſe be arranged under three claſſes, of which,

The *firſt* comprehends thoſe ſubſtances which have the ſame degree of affinity to the irritable principle, or oxygene, as the organized fibre itſelf. Theſe ſubſtances produce no effect upon the fibre.

The *ſecond* contains thoſe which have a leſs degree of affinity to the oxygene, than what the fibre has. Theſe ſubſtances coming in contact with the fibre, will ſurcharge it with oxygene and produce the ſtate of accumulation, and which ſubſtances may be called *negative* ſtimuli.

The *third* claſs contains thoſe ſubſtances which have a greater degree of affinity to the oxygene, than

than even the fibre itſelf has. Theſe coming in contact with the fibre, will of courſe deprive it of its oxygene, and produce the ſtate of exhauſtion. And theſe ſubſtances he calls *poſitive* ſtimuli.

It is a fact known at this time, that the affinity of different ſubſtances varies very conſiderably according to the degree of temperature, and the ſame variations take place in the organized fibre. It may not therefore be irrelavant to obſerve that in ſpeaking generally of the affinities of the irritable fibre, he means always in the ordinary temperature of the blood in warm animals.

The firſt claſs comprehends, as we have obſerved, ſubſtances having the ſame degree of affinity to the oxygene as the irritable fibre. All organized, or living ſubſtances are to be ranked under this claſs*. Theſe ſubſtances produce no

* The words *organized* and *living*, he conſiders as ſynonimous, regarding as living, every body, each part of any body, in a word, all organized ſubſtances, as long as they effect

effect upon the irritable fibre, while their degree of temperature is the ſame as that of the fibre with which they come in contact.

In the third claſs are arranged the *poſitive* ſtimuli, or thoſe ſubſtances which have a greater affinity to the oxygene, than what the fibre has. Theſe ſubſtances coming in contact with the fibre combine with the oxygene it contains, deprive it of its irritabily, and leave it in a ſtate of exhauſtion; of theſe ſubſtances there are a very conſiderable number, and of which the moſt general ones are alcohol, ſulphuric æther, opium, and other narcotics, oil of lauto-ceraſus, and oils in general, greaſe, ſugar, &c.

contain the principle of irritability, or of life, and as long as the affinities are the ſame as thoſe of living ſubſtances. The wood, for inſtance, of which our chairs and tables are made, is an organized or living ſubſtance, and to ſpeak properly, it cannot be ſaid that the wood is dead until it is actually decayed, and ſo of the reſt.

All

All theſe ſubſtances are combuſtible, having a great affinity to oxygene, and from this property it is that they deprive the organized fibre of its irritability, by combining with the oxygene it contains.

The ſecond claſs, we have ſaid, comprehends the negative ſtimuli, or ſubſtances which have a leſs affinity to the oxygene, than what the fibre has. And under this claſs muſt be ranked ſome of the moſt terrible poiſons with which we are acquainted.

The oxygene which combines with the organized fibre, when it comes in contact with theſe poiſons, renders it ſo extremely irritable, that the weakeſt ſtimulus is capable of producing death; by a law of irritability which has already been explained.

It is on this account that *oxygenated marine acid* is ſo fatal a poiſon to all organized bodies. It deſtroys

deſtroys them by ſurcharging them with irritability, and becomes *marine acid* by this operation.

Arſenic, in its metallic ſtate, has no effect upon animals; but the white oxid of this metal is one of the moſt dreadful poiſons, for it hyperoxygenates the organized fibre with which it comes in contact, re-aſſuming its metallic form.

Similar effects are produced by the oxygenated metallic ſalts, as oxygenated muriatic ſublimate of mercury, &c.

The oxids of ſilver and mercury produce greater or leſs effect upon the organized fibre, in proportion as they contain more or leſs oxygene. The black oxid of mercury, otherwiſe called æthiops, produces but very trifling effects; but the moſt terrible effects are produced from the red oxid of this metal, which deſtroys organized bodies in a very ſhort time.

The ſame explanation, applies equally to the action of ſulphate of tin, and of lead; as alſo to that of the acetate of lead and of braſs upon the organized fibre.

Dr. Girtanner ſeems fully convinced that the organized fibre, both of animals and vegetables, decompoſes the water with which it comes in contact, the greateſt portion of the water we drink being firſt decompoſed, and afterwards re-compoſed.

It is indeed one of the means by which nature furniſhes organized bodies with the oxygene neceſſary to the preſervation of their irritability and life. And on this diſcovery, many phenomena hitherto inexplicable may readily be explained; perhaps too that æra is not far diſtant, when from theſe important diſcoveries we may be enabled to deduce an explication of the moſt hidden myſteries of animal phyſiology.

The

The ſame author ſuppoſes that the hydrogene air which remains, after the oxygene of the water is united to the irritable fibre, may ſerve to ſupply the loſs of nervous fluid, or rather that this hydrogene air, is itſelf the nervous fluid, or perhaps carbonic hydrogene air.

We have already remarked that the ſenſation of hunger in animals, was the conſequence of irritability accumulated in the ſyſtem; and that in order for any ſubſtance to be nutritious, it muſt be a poſitive ſtimulus; or one that has a very conſiderable tendency to combine with the oxygene, ſince it is only by its union with this principle, with which the ſyſtem is ſurcharged, that it can be enabled to reſtore the tone of the fibre, and allay the painful ſenſation of hunger..

Every phenomenon ſeems to ſupport this theory; different ſubſtances nouriſhing only in proproportion to their affinity with oxygene living animal ſubſtances, as oyſters, &c. afford but very

little

little nouriſhment, becauſe they cannot combine with the oxygene, being already ſaturated with that principle; hence the common obſervation, that oyſters encreaſe the appetite.

Animal jellies, fruits, and vegetable ſubſtances, in general afford very little nouriſhment. Animal food recently killed, does not afford equal nutrition with that which has been kept ſome time; nor is raw meat ſo nouriſhing as that which has been cooked. Hence all the art of cookery conſiſts in depriving the food of its oxygene, by the application of different ſtimulating ſubſtances, and eſpecially the ſtimulus of heat.

Roaſting, is perhaps the moſt ſimple mode of cooking the food; by expoſure to heat, it parts with its oxygene, as in the 19th experiment.

Oils, fat, ſugar, alcohol, and other ſubſtances which have a great affinity to oxygene, are very nouriſhing. And in the Eaſt-Indies, millions of men

men are ſupported, ſolely by ſmall quantities of opium, when the rice harveſt fails them, as is very frequently the caſe in thoſe wretched countries groaning under the deſpotiſm of a company of * * merchants.

Thirſt is a ſtate of the ſyſtem very oppoſite to that of hunger; it is a ſenſation which induces a ſtate of exhauſtion, or in other words, a deficiency of oxygene.

Every thing that is capable of reſtoring to the fibre its loſt oxygene, puts an end to this diſagreeable ſenſation. Water produces this effect by its decompoſition which takes place when it comes in contact with the fibre.

The ſame effect will be produced by the vegetable acids, which are always decompoſed in the ſtomach of animals.

It

It is only in proportion to the quantity of oxygene which enters into the compoſition of the acid, and to which they have but little affinity, that they refreſh and allay the ſenſation of thirſt.

Thus vegetable acids are the moſt powerful remedies againſt the effects of narcotic poiſons; for by their decompoſition they reſtore to the fibre an equal quantity of oxygene with that of which it had been deprived by the poiſon.

Vinegar taken in large doſes, cauſes the ſtate of exhauſtion produced by a ſtrong doſe of opium, and prevents death, which might otherwiſe enſue.

It is a well known fact, that drunken perſons, become leſs inebriated, by drinking a glaſs of vinegar, reſtoring the tone of the ſyſtem which had been loſt by the effect of the alcohol contained in the wine. Water, only in much more conſiderable quantities, will produce the ſame effect.

Per-

Perhaps many other phenomena are to be explained upon the ſame principles.

The phenomena diſplayed by the rotifer are indeed truly aſtoniſhing; that ſingular inſect, though entirely dried up, may be revived by moiſtening it with a drop of water; this phenomena which hath hitherto appeared inexplicable, would ſeem eaſily to be accounted for on theſe principles.

The drop of water becomes decompoſed, and the oxygene which it contained combining with the rotifer, reſtores its irritability, its life, and organic motion, of which it have been deprived by the ſtimulus of heat, to which it had been expoſed in becoming dry.

Among the known poſitive ſtimuli thoſe which are capable of producing the greateſt effects are the ſtimuli of putrid fevers, or of the plague, and that of the mephitis, which is exhaled during the putrefaction of animal ſubſtances, in places where atmoſ-

atmoſpheric air cannot enter, as in tombs and burial places, &c.

This mephitic gaz has ſo great an affinity with oxygene, that as ſoon as it comes in contact with the fibre, it deprives it of its oxygene, and produces death, frequently in an inſtant. The moſt efficacious mode of preventing the fatal effects of this gaz is by the detonation of nitre upon burning charcoal.

During the decompoſition of the nitre a conſiderable quantity of oxygene air eſcapes, and ſupplies the oxygene which combines with the mephitic air. This theory would ſeem fully proved, from the workmen who have been ſuffocated by the mephitic air exhaling from tombs, having (to uſe their own expreſſions) recovered their ſenſes and been refreſhed, as ſoon as they have been made to reſpire oxygene air.

Dr. Girtanner found that many ſtimulating ſub-

ſubſtances, but more eſpecially alcohol, opium, the ſolution of white oxid of arſenic, vinegar, water, heat, and the oxid of mercury, produced ſimilar effects upon plants as they had done upon animals; that the moſt irritable plants, ſuch as the mimoſa and hediſarum, may be entirely deſtroyed by poſitive ſtimuli, as for inſtance, by opium, alcohol or heat, and that it is poſſible to give very ſenſible irritability to plants, which did not *a priori* appear to poſſeſs it, by applying, for ſome time, negative ſtimuli, ſuch as vinegar, or white oxid of arſenic.

He obſerves, that he has found oils, and alcohol, when uſed in ſmall quantities, are ſpecific remedies for the diſeaſes of plants, produced by accumulation of the irritable principle; diſeaſes which are marked by the yellow colour of the leaves.

It may very naturally be expected that numerous hints of no inconſiderable utility to medicine

and agriculture, may be collected from these discoveries, by shewing us the true nature of animals and plants, their several diseases, and the means of remedying them.

This theory of Dr. Girtanner's, like that of every other which preceded it, is not without its palpable defects.

We cannot suppose that any substance which directly, and without any appearance of previous excitement, in whatever quantity they are administered, such as lead diminishes the action of life, is a less powerful stimulus; for in what manner, on this principle, can they diminish the effect of the ordinary stimuli, which are applied at the same time?

It is equally well observed by Dr. Beddoes that universal experience must immediately reject his idea of the depressing passions being only the abstraction of the stimuli of the exciting passions.

We

We muſt, ſays Dr. Beddoes, where obſervation indicates it, admit a power in ſome drugs, in ſome of the paſſions, and in ſome external circumſtances, either of preventing the ſyſtem from giving out its excitability, or from accumulating it, (which ſtate is very often ſeen, where a continuance of ſleep ſufficient as to its duration does not refreſh, or according to Dr. Cullen's expreſſion, *render the ſyſtem more liable to be affected by ſtimuli of all kinds*), or on the contrary, of accumulating it too rapidly. We are even enabled by the foregoing hypotheſis to conceive a modus operandi in all theſe caſes.

Theſe principles, ſays he, with which the late wonderful diſcoveries of Galvani, Valli, and Volta, ſeem perfectly well diſpoſed to coaleſce, promiſe all thoſe advantages which would reſult from a perfect knowledge of the mechaniſm of the animal functions.

Was not Mayow, ſays he, infinitely nearer the truth,

truth, than any author of a later hypotheſis when he attributed muſcular motion to the *effervescence of his nitro-atmoſpherical particles ?* Does not muſcular contraction or intumeſcence really depend upon the combination of oxygene with hydrogene and azote (ſeparately and combined, in various proportions), in conſequence of a ſort of exploſion produced by the nervous electricity ?

According to this hypotheſis, animal motion, at leaſt that of animals analogous to man, would be produced by a very beautiful pneumatic machinery ; and our nervous and muſcular ſyſtems may be conſidered as a ſort of ſteam engine.

Although this hypotheſis, may not at this moment be capable of ſtrict and ſufficient proof, yet it is not only extremely probable but alſo would ſeem to be ſupported by every obſervation and experiment yet made upon the ſubject.

It accounts for the continual neceſſity of our in-

inhaling oxygene and enables us to trace the changes which this ſubſtance undergoes, from the moment of its being received to that of its expulſion.

By the blood it is imparted to the muſcular fibres; and during their contraction combines with the elements above mentioned, into water and various ſalts, among which the marine and phoſphoric acids deſerve particular notice; and of which, as exiſting in the blood, &c. we have already had occaſion to ſpeak, in a former part of this eſſay.

From thoſe few obſervations cited in the preceding pages, we may be very eaſily convinced of the immediate neceſſity of oxygene to muſcular motion; and that where this principle is not ſupplied in ſufficient quantity, the power of motion will be proportionately languid.

Dr. Beddoes remarks that *meat* becomes tender

by

by the ſecondary combination of oxygene, in whatever manner this ſecondary combination be effected; whether by keeping it till the putrefactive proceſs takes place more or leſs; by cookery; by obliging the animal to undergo violent exerciſe before death, as in hare-hunting, bull-baiting and in an expedient of gluttony, rather more barbarous than either of the preceding, that of flogging poultry to death.

The fleſh of animals ſo deſtroyed ought alſo to be more ſucculent, as well as more tender.

Many experienced ſportſmen have obſerved that an hunted hare will continue to emit ſteam, for a much more conſiderable time, after being brought to table, than an hare killed by any other means, and myſelf as well as others have *frequently* heard the ſame remark in regard to hunted veniſon.

Theſe phenomena correſpond perfectly with the ſup-

ſuppoſition of liquids partly volatile, being generated during muſcular action.

In the Weſt Indies, it is a very frequent cuſtom to kill their poultry with vegetable poiſon, in order to render them tender without keeping, and various ſtimuli, which are only leſs violent poiſons, are occaſionally uſed for the ſame purpoſe in this country. It is not aſcertained with certainty, whether they produce their effects immediately or by firſt exciting the nervous electricity.

But whatever be the direct mode of action of theſe ſtimuli and poiſons, that of contagious miaſmata would ſeem to be exactly the ſame.

Dr. Beddoes relates a caſe in which he could not doubt that complete intoxication was produced by the contagion of typhus, to which the perſon had been much expoſed.

" One morning, immediately upon riſing, and

I know that he had been perfectly ſober the night before, I was aſtoniſhed to obſerve that ſlighty vivacity and diſpoſition to wild disjointed talk, together with the other ſigns which infallibly denote a certain degree of intoxication, eſpecially when you are well acquainted before hand with the manners of the party. In the courſe of the day, during which I ſaw him frequently, he became heavy, had febrile ſhiverings, and complained of the head ache.

" The next day he became more feveriſh, but was not confined till the fifth day, though the head-ache, and other ſymptoms never quitted him. He paſſed through all the ſtages of typhus, but never ſeemed to be in imminent danger."

To this the Doctor adds what we would deem a very important obſervation, " That, in moſt inſtances, the period of the excitement of the brain is not perceived ; we however, frequently ſee the action of the voſcular ſyſtem increaſed at gene-

the onſet of typhus. This increaſe of action ſometimes miſleads practitioners into the fatal meaſure of blood-letting.

The ſame author ſuppoſes, and perhaps with every degree of truth which analogy might afford, that the more highly ſaline ſtate of the wine in febrile diſeaſes, and after exerciſe, depends on the chemical combinations above mentioned.

The ſimilarity of ſymptoms in typhus and ſcurvy has frequently been noticed; and the ſimilar ſymptoms of theſe diſeaſes ſeem evidently to depend upon the ſame cauſe; the contagion of typhus depriving the ſyſtem of oxygene, by producing the combination of a great part of that which it already contains. Hence, as Dr. Beddoes very aptly obſerves, it is probable that the true indication of cure in typhus is to reſtore the oxygene; and it is highly probable that upon this principle, a certain and ſpeedy cure may ere long be contrived.

The preſent ſtate of modern practice which authorizes the, perhaps too liberal uſe of ſtimulants, though, certainly upon the whole more beneficial than the contrary, is yet by no means ſuch as we ought tacitly to acquieſce in. It does not enſure ſo much ſucceſs as might be expected from a method founded on juſt and invariable principles; and perhaps the different methods in uſe anſwer pretty much alike, the diſeaſe being but little in the power of the phyſician.

Oxygene may be more beneficial at one ſtage of typhus than at another.

Thoſe caſes in which typhus ſupervenes after expoſure to ſevere cold, at a time when it is impoſſible, by the ſtricteſt ſcrutiny to diſcover any previous veſtiges of contagion in the neighbourhood, render it highly probable that this diſeaſe may be produced by ordinary ſtimuli when applied to excitability much accumulated.

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The ſymptoms of the influenza, which are very difficultly to be diſtinguiſhed from thoſe of catarrh, as well as the effect produced by the Steward's viſit to the natives of St. Kilda, (if this reſpectably atteſted, though ſurprizing narrative be true) afford another inſtance where diſeaſes, extremely ſimilar at leaſt, are produced by ordinary ſtimuli, and by the extraordinary ſtimulus of contagion.

If the marſh-miaſma be not an imaginary being, there is reaſon to preſume the ſame thing of intermittents, which very often appear where marſh-miaſma cannot well be ſuppoſed to exiſt.

It is very probable that the feveriſh ſymptoms, or indirect debility, which very generally, or rather perhaps in every inſtance, ſucceed to intoxication, may be relieved, or perhaps entirely removed, by the perſons being made to reſpire oxygene air.

This,

This, Dr Beddoes ſuppoſes, would not only make up the want of this principle, but might alſo reſtore the nervous electricity; a circumſtance to which it will no doubt be always neceſſary to attend in diſorders of excitement, or ſuch as are produced by excitement.

I have myſelf found an almoſt immediate alleviation of thoſe ſymptoms which attend a ſlight degree of inebriety, by the detonation of nitre upon burning charcoal; but as we are now engaged in ſome experiments which have not been proſecuted a ſufficient length to authorize any certain concluſions therefrom, we ſhall defer entering into the ſubject more particularly in this place, but ſhall take an opportunity of giving their reſult to the world in a future publication.

From the experiments of Meſſrs. Sauſſure and Volta, on the electrical phenomena attending condenſation, Dr. B. thinks it may reaſonably be con-

conjectured that animal electricity is renewed by reſpiration. The want, he adds, of ſome certain method to effect this may, perhaps, give riſe to ſome doubt in the mind of the reader, reſpecting the certain efficacy of an hyper-oxygenated atmoſphere in typhus; but the few trials that have hitherto been made upon the reſpiration of oxygene air, ſeem to him more than adequate to counterballance this doubt.

From what has been advanced in the foregoing pages, we may readily infer that the gaſeous ſubſtance, called by Dr. Prieſtly *vital air*, and by modern chemiſts *oxygene gaz*, is perhaps the moſt eſſentially neceſſary agent in the numerous operations of the animal œconomy.

We find it exiſting in combination with a variety of ſubſtances; and from which it is very readily procured by their decompoſition.

Some

Some metallic oxids yield this gaz in a very pure ſtate, by ſimple diſtillation, and receiving it in the hydro-pneumatic apparatus. Thus from one ounce of the red precipitate, or *oxidum hydrargyri rubrum acido nitrico confectum*, near a pint of gaz may be obtained.

It is this gaz which conſtitutes the baſe of all acids, and from ſome of which it is very eaſily ſeparable.

Thus from one pound of nitre may be obtained twelve hundred cubic inches, or thereabout, of oxygenous gaz, which is ſet at liberty by the decompoſition of the nitric acid.

Plants and vegetables likewiſe, when in a ſtate of health and expoſed to the light of the ſun, emit vital air*.

* This curious fact was firſt noticed by Prieſtly, Ingenhouſz, and Senebier.

This

This air may be readily procured from plants, by encloſing them beneath a glaſs veſſel full of water, inverted over a tub filled with the ſame fluid. As ſoon as the plant is acted upon by the ſun, ſmall air bubbles will be obſerved forming on its leaves which ſoon detach themſelves, and riſing to the ſuperior part of the veſſel, diſplace the liquid.

Hence it would appear that the animal and vegetable kingdoms are not ſupported by one and the ſame principle; for while plants abſorb azotic gaz or atmoſpheric mephitis, and emit vital or oxygenous air, man, on the contrary, exhales a conſiderable quantity of mephitis, and owes the continuance of his exiſtence to the abſorption of oxygene or vital air, and thus by a kind of reciprocity of ſervices the two kingdoms would ſeem to labour for each other*.

* Vide Chaptal's Elements of Chemiſtry, tranſlated by Nicholſon.

Oxy-

Oxygene gaz exhibits certain properties according to its degree of purity, and the ſubſtances which afford it. That which is obtained from mercurial oxids, M. Chaptal ſuppoſes, always holds in ſolution a ſmall quantity of mercury; and he obſerves that in two caſes he has been witneſs to its having produced a ſpeedy ſalivation, when uſed for diſorders of the lungs.

We have before remarked that oxygene gaz was neceſſary to the proceſs of combuſtion; nor indeed can any combuſtion take place without the preſence of this gaz.

In the proceſs of moſt combuſtions oxygene gaz becomes concrete, ſetting at liberty the caloric principle to which its aëriform ſtate was owing. Thus being forced from its former combination it produces heat, endeavouring to combine with the neareſt ſubſtances.

It is this gaz alone which is proper for reſpiration, and from this peculiar and moſt eminent property its firſt diſcoverer* gives it the name of *vital air*.

In a former part of this work we have had occaſion to ſpeak ſomewhat fully on the phenomena of reſpiration; yet we truſt the majority of our readers will not deem it unneceſſary or unintereſting that we ſhould here make ſome curſory obſervations on that important function.

The ancients ſeem to have been fully ſenſible of its connection with the welfare of animal life. They admitted in the air a principle neceſſary to the ſupport of life, which they termed *pabulum vitæ* and Hippocrates himſelf expreſsly ſays, *ſpiritus etiam alimentum eſt*.

* It was diſcovered by the celebrated Dr. Prieſtly on the memorable 1ſt of Auguſt, 1774.

Various have been the ſyſtems which have ſucceeded to that idea, all equally void of reaſon or foundation.—Sometimes the air was ſuppoſed to be a ſtimulus in the lungs, neceſſary to keep up the circulation by its continual action*.

By others the lungs have been conſidered as a ſort of bellows deſigned to cool the body, previouſly heated by a thouſand imaginary cauſes; and upon its being proved that the volume of air was diminiſhed in the lungs, every difficulty was thought to be cleared up, by ſaying that the air was deprived of its elaſticity.

Modern experiments and obſervations have however thrown very conſiderable light on this moſt important function of the human body.

I believe it is univerſally admitted that no animal can live without the aſſiſtance of air, but the diſcovery is but of modern date, which has given

* Vide Haller.

riſe

riſe to our preſent knowledge concerning that principle in the atmoſphere, more eſſentially ſerviceable for the purpoſes of reſpiration, and to which has been given the appellation of vital air or oxygenous gaz. But the ſame degree of purity in the air is not required in all animals. Birds, men, and the greater number of quadrupeds, require a very pure air; but ſuch animals as live in the earth or hide themſelves in a dormant, or ſtupefactive ſtate during winter, do not require ſo pure an air as neceſſary to their exiſtence.

Theſe are not the only circumſtances in which the ſtate of reſpiration in the varieties of animals differ. The very *mode* of reſpiring air varies in different ſubjects.

Moſt animals are ſupplied with an organ, for the purpoſe of receiving the fluid in which the animal lives, and expelling from the ſyſtem ſuch matters as are become uſeleſs, or deleterious thereto: and according to Mr. Brouſſonnet is more

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or leſs perfect, and defended from external injury in proportion to its importance and influence upon the life of the individual.

M. Chaptal obſerves that although amphibious animals reſpire by means of lungs, yet can they ſuſpend the action of theſe organs even while they are in the air; particularly frogs, which he ſays, can ſtop their reſpiration at pleaſure.

Fiſhes reſpire in a very different manner from moſt animals. They are under the neceſſity of coming from time to time to the ſurface of the water, for the purpoſe of inhaling air, with which having filled their veſicle they retire to digeſt it, ad libitum.

The laſt mentioned author, having paid very minute attention, and for a conſiderable time, to the phenomena of reſpiration in fiſhes, concludes that they are ſenſible to the action of all the gazes, in like manner as all other animals. It has been

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obſerved by M. de Fourcroy, that the air contained in the veſicle of a carp is nitrogene gaz*.

The reſpiratory organs of inſects are ſtill more imperfect than thoſe of man; exhibiting many very ſtriking marks of analogy with vegetables.

The formation of their organs are particularly ſimilar, being diſpoſed alike throughout the whole body of the animal and vegetable, nor do inſects require the air to be particularly pure; and plants, we have obſerved, are nouriſhed with atmoſpheric mephitis; but both plants and inſects tranſpire oxygenous gaz, or vital air†.

* The *Phlogiſticated air* of Dr. Prieſtly.

† The Abbé Fontana diſcovered ſeveral inſects in ſtagnated waters, which, when expoſed to the ſun, afforded vital air: and the green matter which is formed in ſtagnant water, and placed by Dr. Prieſtly among the confervæ, in conformity with the opinion of Bewley—which was ſuppoſed by Mr. Senebier to be the *conferva ceſpitoſa filis rectis undique di-*

Theſe

Theſe are not the only circumſtances in which ſimilarity is found to exiſt; for by chemical analyſis principles may be obtained from inſects, ſimilar to thoſe of plants, as reſins, volatile oils, &c.

Animals, on the contrary, are capable of reſpiring only from the aſſiſtance of oxygene air, on the proportion of which alone depends their freedom of reſpiration. The experiments of Count Morozzo fully confirm this*, and from them it may be concluded—

vergentibus Halleri, and which has appeared to Dr. Ingenhouſz to be nothing elſe than a maſs of animalcula—affords a prodigious quantity of this air when expoſed to the ſun.

* He placed ſucceſſively ſeveral full grown ſparrows under a glaſs bell, inverted over water. At firſt it was filled with atmoſpheric air, and afterwards with oxygene gaz, or vital air. He obſerved firſt in atmoſpheric air, that—

	Hours.	*Minutes.*
The firſt ſparrow lived —	3	0
The Second — — —	0	3
The third — — —	0	1

1. That animals live longer in vital, than atmoſpheric air. 2. That an animal can live in air in which another has died. 3. That independent of the nature of the air, reſpect muſt be had to the conſtitution of the animal*. 4. That there is

During the life of the firſt the water roſe in the veſſel eight lines; and during the life of the ſecond, four; but no abſorption was produced by the third. He then filled the veſſel with vital air, in which—

	Hours.	*Minutes.*
The firſt ſparrow lived —	5	23
The ſecond — —	2	10
The third — —	1	30
The fourth — —	1	10
The fifth — —	0	30
The Sixth — —	0	47
The ſeventh — —	0	27
The eighth — —	0	30
The ninth — —	0	22
The tenth — —	0	21

* This appears from the *ſixth* ſparrow having ſurvived 47 minutes, and the *fifth* only thirty.

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an abſorption of air, or a production of a new kind of air, which as it riſes is abſorbed by the water†.

If the expired air which iſſues from the lungs be made to paſs through lime water, it renders it turbid; if through tincture of turnſole, it reddens it; and if pure alkali be ſubſtituted in place of the latter, it becomes effervescent.

The carbonic acid is abſorbed in the foregoing proceſs, leaving nitrogene gaz and vital air. The preſence of which laſt is aſcertained by nitrous air.

Frugivorous or graminivorous animals have been obſerved to vitiate the air leſs than carnivorous animals.

Borelli formerly obſerved that a portion of the air is abſorbed in reſpiration; which the ex-

† Vide Chaptal's Chemiſtry.

periments

periments of Dr. Jurin* confirmed, but the celebrated Dr. Hales‡ endeavoured to aſcertain this abſorption more accurately; yet as he paſſed the expired air through water, his proceſs could not be ſufficiently depended on.

M. De la Metherie has proved, by more accurate experiments, that three hundred and ſixty cubic inches of vital air are abſorbed in the courſe of one hour; perhaps however the conſumption is not near ſo great—However that may be, it affords ſufficient proof of the facility with which air is vitiated by reſpiration if it is not renewed, and confirms what we have before had occaſion to ſay with regard to the air of theatres, &c. being in general ſo extremely unwholeſome.—And further, by air which has been kept in contact with blood, being incapable of ſupporting flame, and by its precipitating lime-water.

* Deſſert. 4. Lib. 4.

‡ Veget. Statics, Vol. 2nd—See alſo *Borelli* de Motu Animal, Lib. 11—*Sauvage* de Reſpiratione difficili.—*Bernoulli* Diſſert. de Reſpiratione.

The influence of vital or oxygene air upon the blood is confirmed by the teſtimony of ſo many and reſpectable authors as ſcarcely to leave room for the ſmalleſt degree of doubt. M. Thouvenal has proved that by exhauſting the air from its contact with the blood, it will be again deprived of its colour; which Mr. Beccaria alſo confirmed by expoſing blood in a vacuum, where the blood remained black, but upon admitting the air it aſſumed a moſt beautiful vermilion colour.

M. Cigna having covered blood with oil, found that it preſerved its black colour.

Dr. Prieſtly alſo found that the intenſity of the colour of blood was in proportion to the quantity of vital air*. From all theſe facts, it appears to be inconteſtibly demonſtrated that the bright co-

* Dr. Prieſtly having filled a bladder with blood, and expoſed it to the influence of vital air, found that portion of blood which touched the ſurface of the bladder, aſſumed a red colour, while the internal part remained black.

lour

lour of the blood is ſolely owing to its combination with oxygene air.

We have already took occaſion to remark, that animal heat was derived to the ſyſtem from this combination, but we might go ſtill further, and add from the obſervations of the Count De Buffon and M. Brouſſonnet, that the heat in every individual animal, is proportionate to the ſize of the lungs.

Hence M. Chaptal conſiders reſpiration as an operation by means of which vital air paſſes continually from the gaſeous to the concrete ſtate, ſetting at liberty the heat, which held it in the ſtate of gaz. But the heat produced at each inſpiration, muſt uniformly be in proportion to the volume of the lungs, to the action of this organ, to the purity of the air, and to the rapidity and frequency of the inſpirations, &c. Hence the lungs of aſthmatic perſons are incapable of digeſting the air in a proper manner, inſomuch that

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it has been obſerved they emit the air without vitiating it, producing coldneſs of the complexion, &c. and a languid ſtate of the reſpiratory organs; vital air is therefore peculiarly grateful to them. From hence we may readily conceive why animal heat is in proportion to the volume of the lungs; and why ſuch animals as have only one auricle and ventricle, have cold blood, &c.

By the combination of oxygene air with the blood, we have obſerved, carbonic acid is formed, which ſo long as it remains in the ſyſtem may be conſidered as antiſeptic; and according to the experiments and obſervations of the Count De Milly, and Mr. Fouquet, it is afterwards paſſed off through the pores of the skin.

Thus vital air or oxygenous gaz, from its very intimate connection with many of the vital functions, may open a vaſt field for improvement in the practice of medicine. It has been tried very frequently, eſpecially in phthiſical diſorders, and al-

although it does not appear to be adapted to ſuch caſes, yet it has been found to inſpire cheerfulneſs, and render the patient happy; at leaſt, in deſperate caſes, it is moſt certainly a precious remedy, "which can ſpread flowers on the borders of the tomb, and perpare us in the gentleſt manner for the laſt dreadful effort of nature."

It were much to be wiſhed that the nature of the various alterations which take place in the blood were better aſcertained by accurate analyſis rather, than that phyſicians ſhould be left to judge of theſe varieties merely by external appearances; eſpecially in the different diſeaſes, which produce the more peculiar and conſiderable alterations in this fluid; as in ſtrong inflammations, chloroſis, ſcorbutic diſorders, &c.

From the preceding analyſis of the blood ariſes that knowledge which we at preſent have of that fluid; and hence we may find it to be compoſed of a variety of particles, differing in bulk, denſity

ſity, figure and tenacity; ſome aqueous, others inflammable; and moſt of them much inclined to putrefaction, and of an alkaline nature.

The exact quantity of blood contained in a living animal, cannot be exactly computed, but it is very generally believed, that the maſs of humours very much exceeds that of the ſolids; although it is to be obſerved, that ſome of them as the gluten and fat of particular parts, do not flow in the circulation: but if from thoſe profuſe hæmorrhagies which have been ſuſtained without affecting the deſtruction of animal life, and from experiments made on animals by drawing out all, or as much as poſſible of their blood, the circulating humours will be found to amount, to at leaſt fifty pounds; of which maſs twenty eight pounds will be true red blood circulating through the arterial and venous ſyſtems, the former containing four parts, and the latter nine.

But the blood does not always contain the above men-

mentioned principles in the ſame proportions. For laborious and ſtrong exerciſes, a full age, fever, &c. by encreaſing its celerity, augments the proportion of craſſamentum, the redneſs, the diſpoſition to coagulate, and the coheſion of its parts: and the ſame means exert a ſimilar influence, on the hardneſs, weight, and alkaline principles of the concreted ſerum; on the contrary the younger the animal and the more it is ſubjected to a ſedentary life, living upon a watery or vegetable diet, the red cruor is proportionately leſſened and the quantity of ſerum and mucus encreaſed. Similar conſequences are likewiſe induced by *old age*.

Sanguification is effected by a peculiar aſſimilating action of the veſſels on the recently abſorbed chyle, which abounds more or leſs in nutritious particles, according to the quantities of gelatinous lymph contained in our aliments.

This chyle when prepared from vegetable food, is always of a thinner conſiſtence than

than the blood itſelf; having entered the circulation it temperates the putreſcent acrimony; by its diluting quality it prevents the threatened coagulation, and reduces the whole maſs to that medium of ſaline nature and conſiſtence which is moſt natural to man.

Such chyle as is principally derived from animal food, or farinaceous vegetables, and is replete with the gelatinous lymph, being applied to the vacuities of each broken ſolid, ſerves to repair the conſumption or waſte made from the body itſelf by the various actions to which it is expoſed.

Few eſculent vegetables, contain this animal glue ſo eſſential to ſanguification; for it is only after many repeated circulations, that, the ſmall portion of jelly, which may be obtained from their farinaceous parts, is converted into the nature of our proper juices. The uſe of vegetables is however extremely neceſſary, ſince they keep the quantity

tity of the blood from exceeding its due bounds, and prevent its tendency to putrefaction.

Animal food alone contains the nutritious lymph ready prepared for the recruit both of our fluids and ſolids, and being extracted from the broken fibres, and veſſels, by the proceſs of digeſtion ; paſſes with the chyle in great abundance to be mixed with the blood.

By uſing animal food alone or in too great quantity, the hot alkaleſcent ſcurvy, a fierce and ſavage temper, a peculiar fætor, and leproſy, with a lixivial ſolution of all the juices, is induced: theſe are only to be cured by a change of diet, to one in which a vegetable acidity is more eſpecially abundant.

From the ſame maſs of blood propelled through the ſyſtem, all the fluids of the human body are generated, which by reaſon of their affinity to one another, may be reduced to certain and diſtinct

claſſes : the manner of their ſecretion and ſeparation from the other component parts of the blood, we have already ſaid muſt be accounted for by the fabric, mechaniſm, and peculiar action of their reſpective ſecretory organs, but an explanation of this would not be eſſential to our preſent purpoſe, and would conſiderably extend the limits of this eſſay ; we muſt therefore refer to thoſe authors who have wrote expreſsly on the ſubject*.

The blood as we have before obſerved undergoes a change in paſſing through the arteries into the veins, this has been ſuppoſed to ariſe from the arterial blood having ſuffered the action of the lungs ; this explanation however would ſeem to convey ſo vague and indeterminate a meaning, that we cannot help again repeating, that it moſt probably depends on a ſeparation of ſome portion of its conſtituent parts having taken place previous to its paſſing into the venous ſyſ-

* Vide Hendy, Haller, Monro, and others.

tem ;

tem; and which are again renewed from the atmoſphere in the courſe of the ſucceeding circulation.

This difference however, though it were not ſo conſiderable as we find it to be, would afford us very conſiderable aſſiſtance in diſtinguiſhing the venous from the arterial blood in caſes of hæmorrhagy; it may alſo, in ſome degree direct us in blood-letting, for if after blood has been drawn and coagulated, it appears of a florid red colour and the craſſamentum and ſerum are nearly equal in quantity, we may infer that the perſon enjoys a tolerably good ſtate of health; and from a deviation of theſe proportions we may form a pretty accurate judgment of the exiſtence of diſeaſe; as, if there are three parts of ſerum to one of the craſſamentum, a debilitated ſtate is indicated, in which caſe we ought to be very cautious not to bleed too profuſely, leaſt we ſhould exhauſt the maſs of all its red globules, as has ſometimes been the caſe, inſomuch that it would not ſtain linen.

If

If on the other hand, the craſſamentum is moſt abundant, we may judge the patient is ſtronger, and conſequently capable of bearing more copious evacuations.

It was an obſervation of Dr. Akenſide's that in the laſt mentioned circumſtance he would preſcribe bleeding more freely than even under the appearance of the inflammatory buff. When the craſſamentum is not firm, but as it were in a ſtate of ſolution, a weak ſtate is always indicated.

Mr. Hewſon obſerves that in peripneumonies, though the ſize appear in conſiderable quantities, yet may not the conſtitution bear bleeding.

It is evident from all theſe conſiderations, that without a denſe and red blood, health cannot ſubſiſt, and if a morbid diminution of its quantity takes place, the juices ſtagnate, and the whole body becomes pale, cold, and weak; and the

cruor

cruor unleſs diluted with a proper portion of aqueous parts, congeals in the minute veſſels, producing obſtruction, inflammation, and all their dangerous concomitants.

From the different combinations of theſe principles, and a due conſideration of the ſolid fibres and veſſels, a variety of temperaments are derived; yet we are aware that neither the various habits nor temperaments of mankind, can originate *ſolely* from any peculiarities in the nature of the blood; nor ought we to attempt the arrangement or deſcription of the different temperaments too ſyſtematically, nor can we comprehend them under any diſtinct number of modifications, their cauſes and effects being various, and the intermediate diverſities perhaps ad infinitum.

Hence we are made ſenſible of the infinite importance of this heterogeneous fluid, and from a minute inveſtigation of the various purpoſes to which

which its component parts are applied; we are led to infer, that it muſt be the firſt ſource of *life* and *organization*, and as it were the *primordial rudiments of all animated nature.*

FINIS.